

## Manual

# L-LAS-LT-Scope V3.1x

(PC software for Microsoft® Windows® Vista, XP, 2000, NT® 4.0, 98)

for laser line sensors of the *L-LAS-LT series*



**STANDARD:**

L-LAS-LT-37  
L-LAS-LT-55  
L-LAS-LT-80  
L-LAS-LT-110  
L-LAS-LT-135  
L-LAS-LT-160  
L-LAS-LT-200  
L-LAS-LT-275  
L-LAS-LT-450

**COMPACT-LINE:**

L-LAS-LT-38-CL  
L-LAS-LT-50-CL  
L-LAS-LT-120-CL  
L-LAS-LT-165-CL  
L-LAS-LT-250-CL

## 0 Contents

Chapter	Page
<b>1. Functional principle: L-LAS-LT with integrated control unit .....</b>	<b>3</b>
1.1 Technical description.....	3
<b>2. Installation of the L-LAS-LT-Scope software.....</b>	<b>4</b>
<b>3. Operation of the L-LAS-LT-Scope software.....</b>	<b>6</b>
3.1 Control elements of the L-LAS-LT-Scope software.....	7
3.2 Numeric and graphic display elements .....	16
3.3 Serial RS232 data transfer .....	18
3.4 L-LAS-LT-Scope as an aid for sensor adjustment .....	19
3.5 L-LAS-LT-Scope as an aid for transmitter power adjustment .....	20
<b>4. Evaluation modes.....</b>	<b>21</b>
4.1 LEFT-EDGE .....	21
4.2 RIGHTEDGE .....	21
4.3 WIDTH.....	21
4.4 CENTER.....	22
<b>5. Data recorder function.....</b>	<b>23</b>
5.1 Data format of the output file .....	24
<b>6. Annex .....</b>	<b>25</b>
6.1 Laser warning .....	25
6.2 Function of the TEACH/RESET button .....	25
6.3 Function of the tolerance potentiometer.....	25
6.4 Function of digital inputs IN0 and IN1 .....	26
6.5 Connector assignments.....	27
6.6 RS-232 interface protocol.....	28

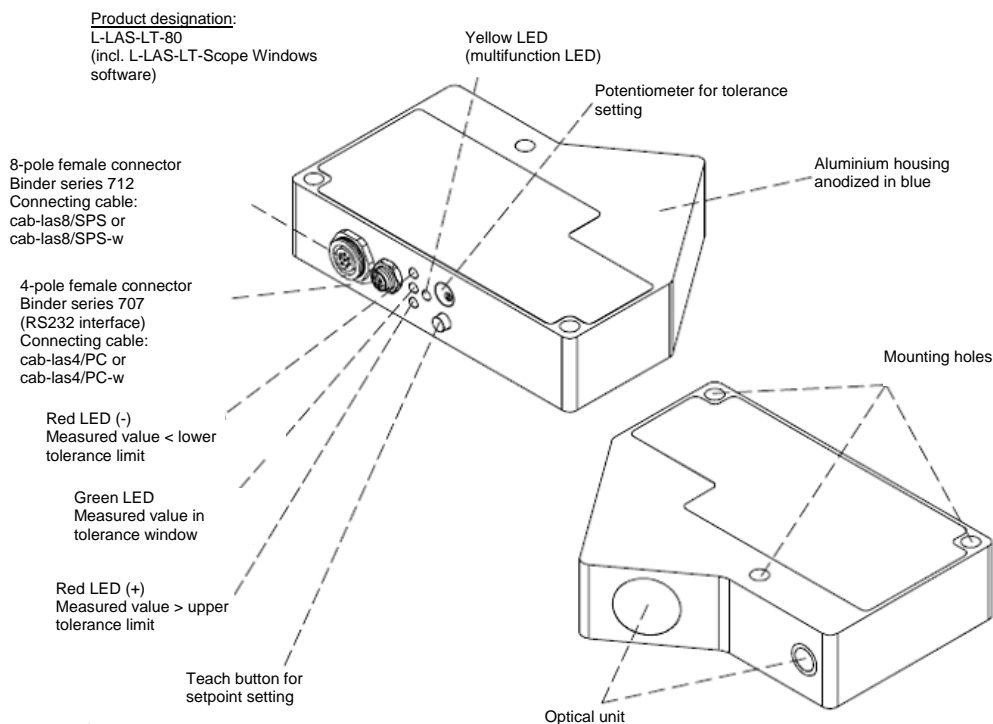
# 1 Functional principle: *L-LAS-LT* sensor with integrated control unit

## 1.1 Technical description

In the laser line sensors of the *L-LAS-LT* series the laser beam of a laser diode ( $\lambda=670\text{nm}$ , 1mW power, laser class 2) through suitable collimators and apertures is emitted from the optical transmitter unit as a parallel laser beam with homogeneous light distribution. After being reflected from the object surface, the laser light impinges on the CCD line receiver of the optical receiver unit. This CCD line comprises many closely adjacent individual receiver elements (pixels) that are arranged in a line. The light quantity of each of these receiver elements that is collected during the integration time can be separately read out as an analog voltage and, after performing analog-digital conversion, can be stored in a data field as a digital value.

Depending on the object distance the laser light that is scattered back from the measuring object (triangulation principle) will only illuminate certain receiver elements (pixels) on the line. Compared to the non-illuminated pixels these pixels will output a considerably higher analog voltage (intensity maxima). By way of suitable software algorithms the areas of the illuminated zones can be determined from the previously stored data field. Since the distance of the pixels on the CCD line is known, the position and distance of the measuring object can therefore be determined.

The micro-controller of the *L-LAS-LT* sensor can be parameterized through the serial RS232 interface by means of a Windows PC software. This allows the setting of various evaluation and operating modes. The housing of the control unit features a TEACH/RESET button and a potentiometer for tolerance setting. Switching states are visualized by means of 4 LEDs (1x green, 1x yellow, and 2x red) that are integrated in the housing of the *L-LAS-LT* sensor. The control unit that is integrated in the sensor has three digital outputs (OUT0, OUT1, OUT2), the output polarity of which can be set with the software. Two digital inputs (IN0, IN1) make it possible to realize an external TEACH/RESET functionality and an external TRIGGER functionality through a PLC. In addition the control unit features a high-speed analog output (0 ... 10V) with 12-bit digital/analog resolution.






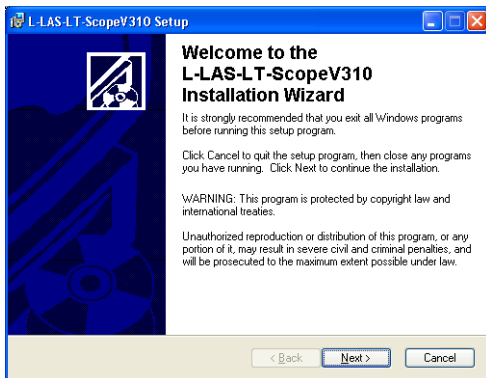
## 2 Installation of the *L-LAS-LT-Scope* software

Hardware requirements for successful installation of the *L-LAS-LT-Scope* software:

- 200 MHz Pentium-compatible processor or better.
- CD-ROM or DVD-ROM drive
- Approx. 10 MByte of free hard disk space
- SVGA graphics card with at least 800x600 pixel resolution and 256 colors or higher.
- Windows 98, Windows NT4.0, Windows 2000, Windows XP, or Windows Vista operating system
- Free serial RS232 interface or USB port with USB-RS/232 adaptor at the PC

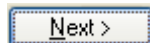
Please install the *L-LAS-LT-Scope* software as described below:

-  1. CD-Laufwerk (D:) Insert the installation CD-ROM in your CD-ROM drive. In our example we suppose that this is drive "D".
-  2. Start the Windows Explorer and in the folder tree of your CD-ROM drive go to the installation folder D:\Install\ . Then start the installation program by double-clicking on the SETUP.EXE symbol.  
 setup.exe  
As an alternative, software installation can also be started by clicking on **START-Run...** and then entering "D:\Install\setup.exe", which must be confirmed by pressing the **OK** button.

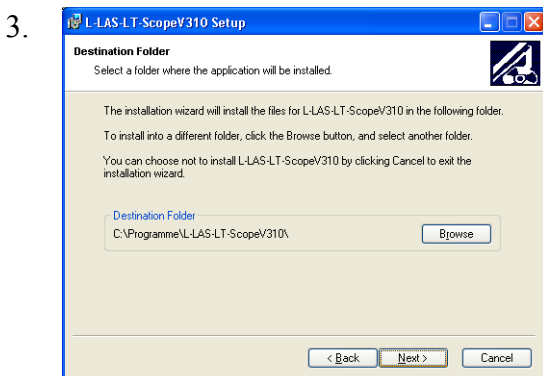
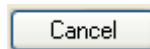


The installation program then displays a dialog box for *L-LAS-LT-Scope* installation. This dialog box shows some general information about installation.

Click on Next> to start the installation

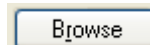


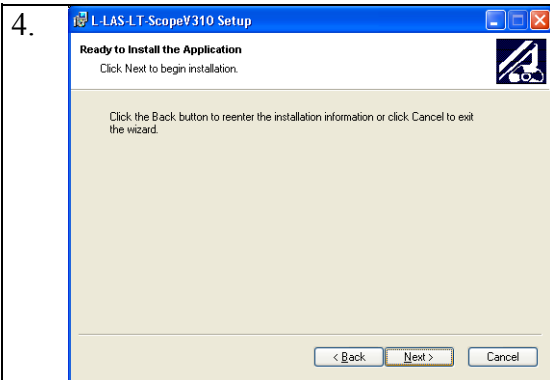
or on Cancel to quit the installation of the *L-LAS-LT-Scope* software.



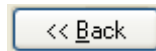
When you click on the Next> button, a new dialog appears for selecting the folder where the application will be installed (destination folder).

You may accept the suggested folder with Next>, or you may change the installation folder as desired by clicking on the Browse button.

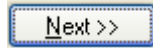




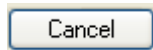
Another *L-LAS-LT-Scope* Setup dialog will be displayed.



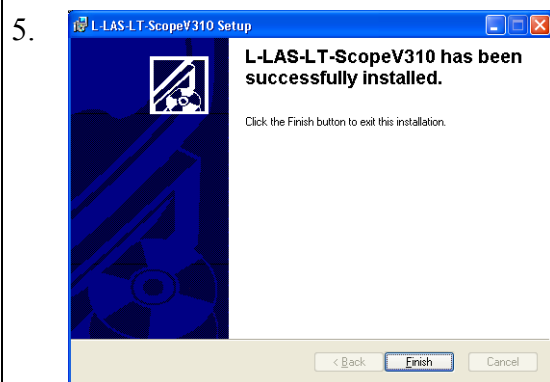
Click on the Back button if you want to change the installation folder again.



Click on Next>> to start the installation, or

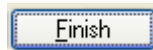


click on Cancel to quit the installation process.



When installation is completed, a dialog box informs you about successful installation.

A new *L-LAS-LT-Scope* program group has been created under Start-All-Programs.



Click on the Finish button to finish the installation.



The *L-LAS-LT-Scope* software can now be started by clicking on the respective icon in the newly created program group under:

Start >All Programs > L-LAS-LT-ScopeV3.1x

#### Deinstallation of the L-LAS-LT-Scope software:



Software

Please use the Windows® deinstallation tool to remove the software.

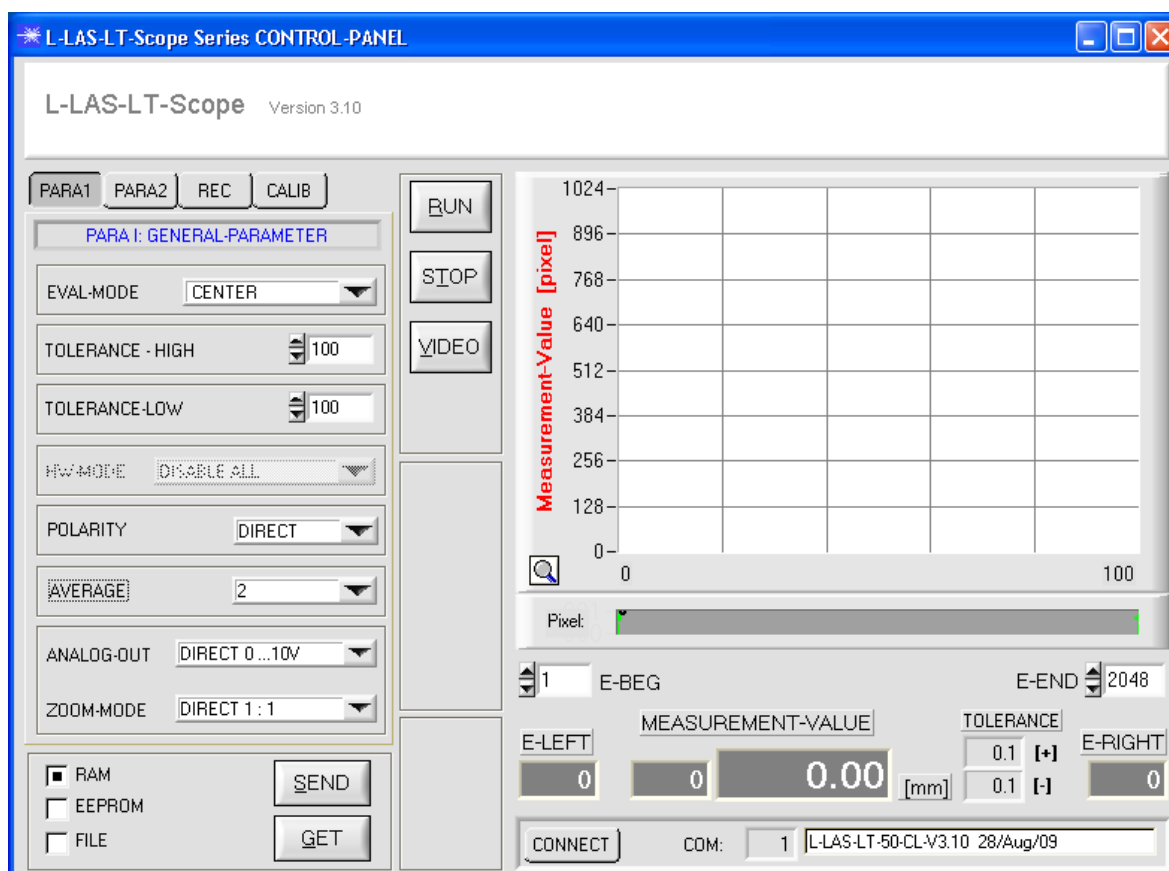
The Windows deinstallation tool can be found under Start / Settings / Control Panel / Software

### 3 Operation of the *L-LAS-LT-Scope* software

The *L-LAS-LT-Scope* software is used for parameterizing the electronic control unit of the *L-LAS-LT* line sensors through the serial interface. The measured values provided by the sensor can be visualized with the PC software, which means that the software among others can be used for adjustment purposes and for setting suitable tolerance limits for the inspection of the measuring object.

Data exchange between the PC user interface and the sensor system is effected through a standard RS232 interface. For this purpose the sensor is connected to the PC with the serial interface cable cab-las-4/PC. When parameterization is finished, the setting values can be permanently saved in an EEPROM memory of the *L-LAS-LT control unit*. The sensor system then continues to operate in "STAND-ALONE" mode without PC.

When the *L-LAS-LT-Scope* software is started, the following Windows® user interface will be displayed:

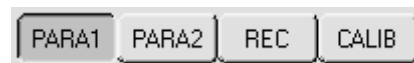
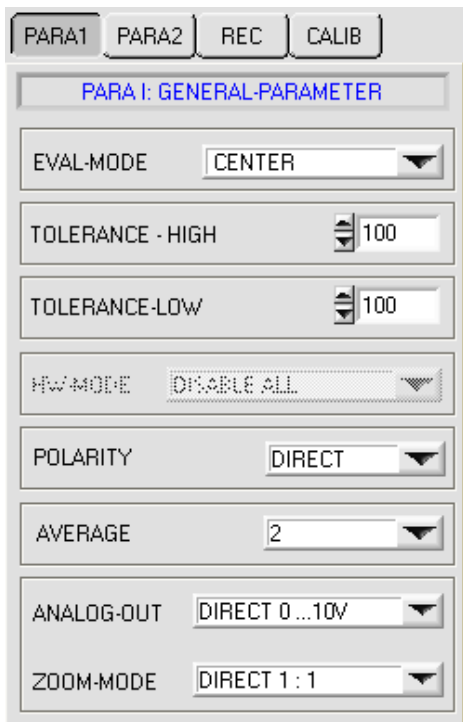


The *L-LAS-LT-Scope* CONTROL PANEL provides a great variety of functions:

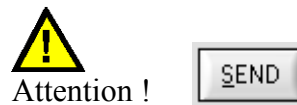
- Visualization of measurement data in numeric and graphic output fields.
- Setting of the laser power for the respective laser transmitter.
- Setting of the polarity of the digital switching outputs OUT0, OUT1, and OUT2.
- Selection of a suitable evaluation mode.
- Presetting of setpoint value and tolerance band.
- Saving of parameters to the RAM, EEPROM memory of the control unit, or to a configuration file on the hard disk of the PC.

**The following chapters provide explanations of the individual control elements of the *L-LAS-LT-Scope* software.**

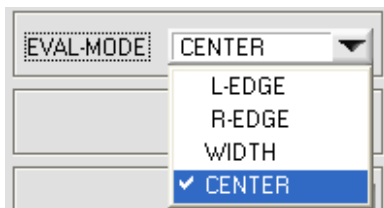
### 3.1 Control elements of the L-LAS-LT-Scope software:



A click on the PARA1 button opens the PARAMETER I window on the user interface. This window is used for setting various parameters at the control unit.



**Changes that are made in the function fields described below only become active at the control unit of the L-LAS-LT sensor after a click on the SEND button!**



Diffuse reflection, normally there is only one intensity maximum at the CCD line.

In the standard version  
**EVAL-MODE = CENTER**  
 is mostly used.

#### **EVAL-MODE:**

List selection field for setting the evaluation mode at the L-LAS-LT sensor.

#### **L-EDGE (LEFT EDGE)**

The first intensity maximum on the CCD line is used as measurement value for evaluation. The intersection points between the video threshold (green horizontal line) and the intensity maximum (red curve) are calculated. The measurement value can be calculated from the detected pixel values. In the standard version the first bright/dark transition = left edge is evaluated.

#### **R-EDGE (RIGHT EDGE):**

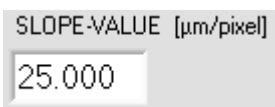
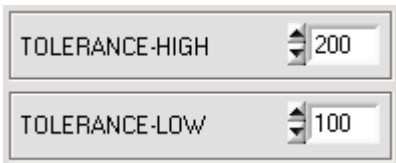
The right edge of the only occurring intensity maximum is used for evaluation.

#### **WIDTH:**

The width of the only intensity maximum is calculated with the help of the video threshold.

#### **CENTER:**

The center of the only intensity maximum is calculated with the help of the video threshold.



### TOLERANCE –HIGH, TOLERANCE-LOW:

In this input field a tolerance default value in pixels can be set for the tolerance limits by entering a numerical value or by clicking on the arrow elements. The tolerance limits are applied around the setpoint value (TEACH-VALUE).

The tolerances currently set at the sensor are shown in [mm] in numerical display fields. If the TOLERANCE potentiometer at the sensor housing is activated, the tolerance value that is set at the potentiometer is displayed here.

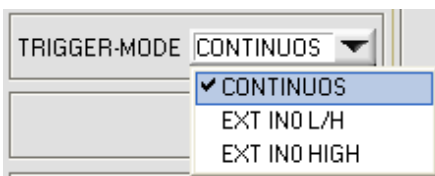
Example for the tolerances in combination with the SLOPE-VALUE

$$TOL[+] [mm] = SLOPE * TOLERANCE\_HIGH$$

$$\text{Here: } TOL [mm] = 25.000 * 200 \text{ Pixel} = 5.00 \text{ mm}$$

$$TOL[-] [mm] = SLOPE * TOLERANCE\_LOW$$

$$\text{Here: } TOL [mm] = 25.00 * 100 \text{ Pixel} = 2.50 \text{ mm}$$



### TRIGGER-MODE:

#### CONTINUOUS:

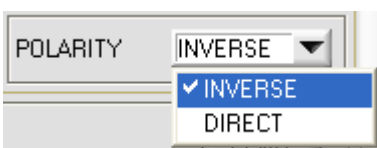
Continuous evaluation of the current measurement values.

#### EXT. IN0 L/H:

External edge-controlled (LOW/HIGH) triggering of measurement value evaluation through digital input IN0/pin3/green at the 8-pol. PLC female connector.

#### EXT. IN0 HIGH:

External triggering of measurement value evaluation by a high-level (+Ub) at digital input IN0/pin3/green.



### POLARITY:

In this function field the output polarity at the *L-LAS-LT* sensor can be set with a mouse-click on the input field or by clicking on the arrow button. The L-LAS-LT sensor has 3 digital outputs (OUT0, OUT1, OUT2) through which error states can be sent to the PLC.

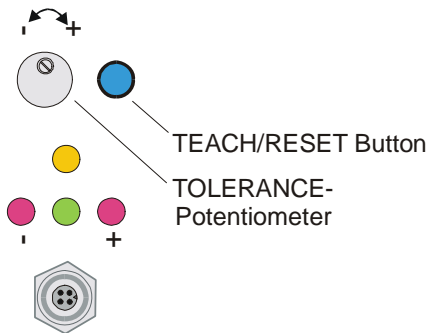
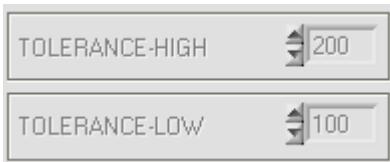
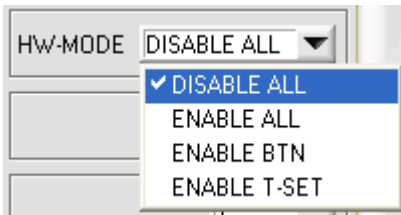
#### DIRECT:

In case of an error the respective digital output is set to +Ub (+15DC ... +30VDC), (red LED on).

#### INVERSE:

In case of an error the respective digital output is set to the reference potential (GND,0V), (red LED on).





### HARDWARE (Hardware mode) [1]:

The TOLERANCE potentiometer and/or the TEACH/RESET button at the housing of the *L-LAS-LT* sensor can be activated (ENABLE) or deactivated (DISABLE) by clicking on the respective item in the list selection field.

The TOLERANCE potentiometer allows the presetting of a tolerance window around the setpoint value. If the function field is set to ENABLE ALL or ENABLE T-SET, it is not possible to enter numerical values in the TOLERANCE-VALUE input field on the PC software user interface. The corresponding function fields are dimmed.

#### DISABLE ALL

Both the TEACH/RESET button and the TOLERANCE potentiometer at the sensor housing are deactivated.

#### ENABLE ALL:

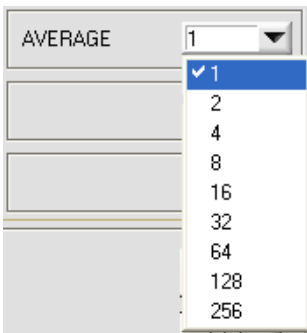
The TOLERANCE potentiometer at the housing is activated. (clockwise turning increases the tolerance bandwidth)  
 The TEACH/RESET button at the housing is activated.  
 Button pressed for a short time ( $t < 0.5s$ ) : RESET.  
 Button pressed for a longer time ( $t > 1.5s$ ) : TEACH.

#### ENABLE BTN:

Only the TEACH/RESET button at the housing is activated.

#### ENABLE T-SET:

Only the TOLERANCE potentiometer at the housing is activated.

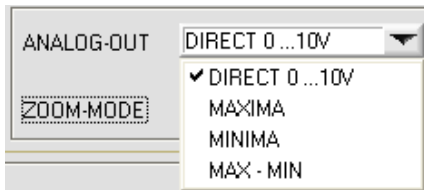


### AVERAGE:

In this function field the averaging at the *L-LAS-LT* sensor can be selected with a mouse-click on the respective list item. With every cycle of the main program the current measurement value is stored in a ring memory field, and then the average of these values in the ring memory field is calculated.

The average of the ring memory field is used as the MEASUREMENT\_VALUE. With the AVERAGE value the size of the ring memory can be set from 1 to 256.

[1] not available for “Compact Line” sensor type (,-CL“)



### **ANALOG-OUT (Analog-Output-Mode):**

Function element for selecting the output mode of the analog voltage at the *L-LAS- sensor* (pin8/red 8-pol. PLC/POWER female connector). The analog voltage is output in the range from 0 to 10V with a resolution of 12 bit.

#### **DIRECT 0..10V :**

A voltage (0 .. 10V) that is proportional to the current measurement value is provided at the analog output pin8/red/.

#### **MAXIMA:**

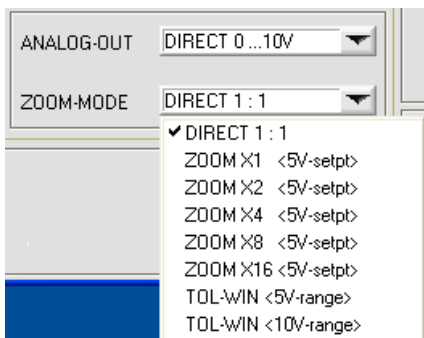
The current maximum value is provided at the analog output pin8/red/ (drag pointer principle, resetting by input IN1/pin4/yellow pulse of <750ms length, or by pressing the TEACH/RESET button).

#### **MINIMA:**

The current minimum value is provided at the analog output pin8/red/ (drag pointer principle, resetting by input IN1/pin4/yellow pulse of <750ms length, or by pressing the TEACH/RESET button).

#### **MAX-MIN:**

The current difference between maximum and minimum value is provided at the analog output pin8/red/ (drag pointer principle, resetting by input IN1/pin4/yellow pulse of <750ms length, or by pressing the TEACH/RESET button).



### **ZOOM-MODE (Analog-Output):**

Function element for setting various zoom modes at the analog output of the *L-LAS-LT sensor*.

#### **DIRECT 1:1:**

At the analog output pin8/red/ the total measuring range of the sensor is provided as a 0 to 10V voltage swing.

#### **ZOOM X1, ZOOM X2 ... ZOOM X16:**

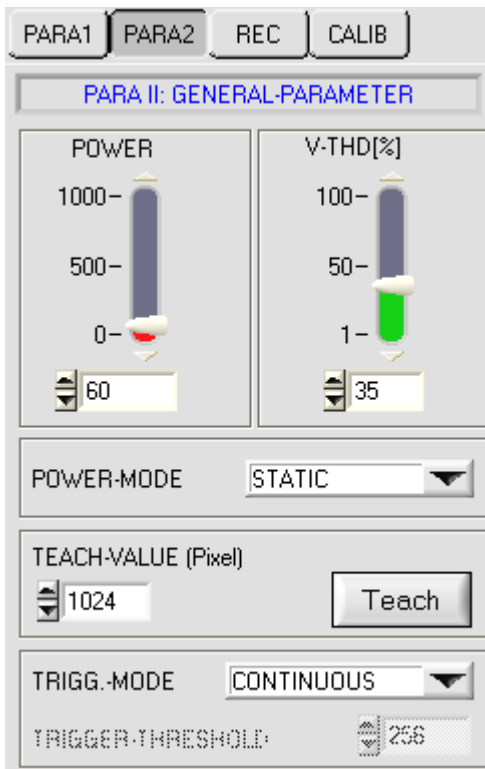
At the analog output pin8/red/ the difference between the current measurement value (pixels) and the teach position (teach value in pixels) is provided. At the teach position a value of 5 V is provided at the analog output. If the current measurement value is lower than the teach position, a voltage < 5V is provided, if the current measurement value is higher than the teach value, a voltage > 5V is provided. The deviation from the 5V teach position can be amplified by a zoom factor of X2 to X16.

#### **TOL-WIN <5V-range>:**

At the analog output pin8/red/ a voltage swing of 5V is provided over the current tolerance window. At the lower tolerance limit the voltage value is 2.5V, at the upper tolerance limit 7.5V. A value of 5V is output at the teach position.

#### **TOL-WIN <10V-range>:**

At the analog output pin8/red/ a voltage swing of 10V is provided over the current tolerance window. A value of 5V is output at the teach position, at the lower tolerance limit the voltage value of the analog output is 0V, at the upper tolerance limit 10V.



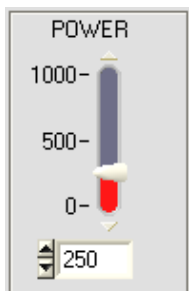
A click on the PARA2 button opens the PARAMETER II window on the user interface. This window is used for setting additional parameters at the control unit.



Attention!



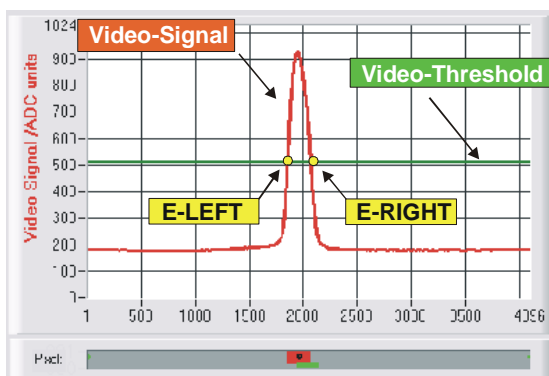
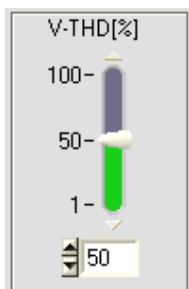
**Changes that are made in the function fields described below only become active at the control unit of the *L-LAS-LT* sensor after a click on the SEND button!**



**POWER:**

**(only relevant with POWER-MODE = STATIC)**

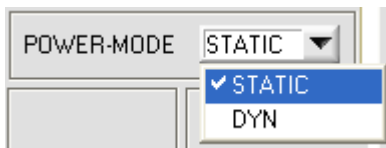
In this function field the laser power at the laser transmitter unit of the *L-LAS-LT* sensor can be set by using the arrows, the slider, or by entering a numerical value in the corresponding input field.



**VTHD[%]:**

In this function field the video threshold at the *L-LAS-LT* sensor can be set by entering a numerical value or by using the slider or the arrows. With the help of this video threshold the measurement values can be derived from the intensity characteristic (video signal) of the CCD line from the bright/dark transitions. For this purpose the intersection points between the intensity profile (red curve) and the adjustable video threshold (green horizontal line) are calculated and stored.

The x-value of the respective intersection point is assigned to a pixel on the CCD line. The measurement value can be calculated from this information and from the known distances of the pixels on the CCD line. The intersection points between intensity profile and video threshold that are provided by this method are hereinafter referred to as edges.



### POWER-MODE:

This function field is used for setting the laser mode at the *L-LAS-LT sensor*.

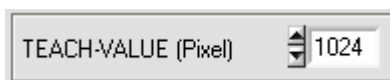
#### STATIC:

The laser power at the master/slave sensor is not automatically controlled. The values that are set at the respective sliders are used as setting values for the laser power.

#### DYNAMIC:

When the operating mode is set to dynamic, the laser power at the *L-LAS-LT sensor* is automatically controlled.

The laser power here is controlled in such a way that the maximum values of the "intensity peaks" approx. are at 80-90% of the analog dynamic range.



### TEACH-VALUE (Pixel):

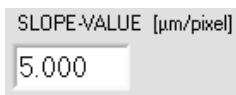
In this function field a teach value can be preset at the *L-LAS-LT sensor* by entering a numerical value or by using the arrows.

#### Please note:

A change of the teach value will only be updated at the control unit when the SEND button is pressed.

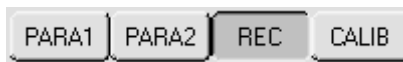
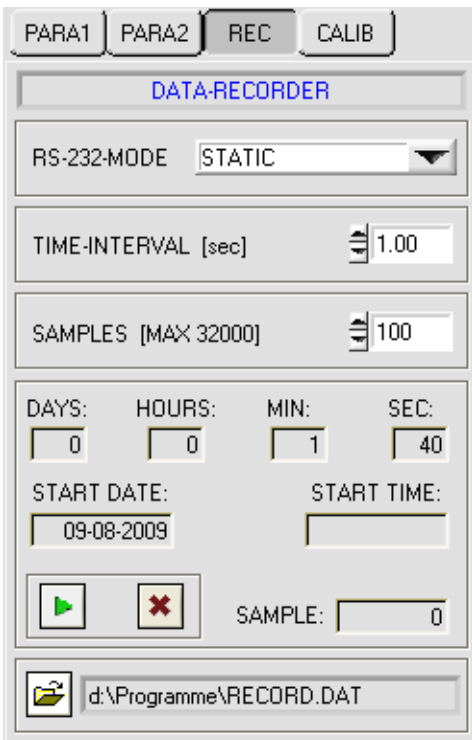
The TEACH-VALUE is set in pixels. As with the tolerance, conversion into  $\mu\text{m}$  can be done by way of the SLOPE-VALUE (sensitivity –  $\mu\text{m}/\text{pixel}$ ).

For example, the result for the *L-LAS-LT-80* is:



$$TEACH\_VALUE [mm] = SLOPE * TEACH [Pixel]$$

$$TEACH\_VALUE [mm] = 5.000[\mu\text{m}/\text{Pixel}] * 1024[\text{Pixel}] = 5.120 \text{ mm}$$



A click on the REC button opens the DATA-RECORDER window on the user interface.

Cf. chapter 5. Data recorder function.



**RS-232-MODE:**

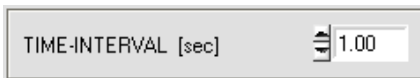
Drop-down function field for setting the data request at the L-LAS-sensor hardware.

**STATIC:**

The sensor does not automatically send measurement data via the RS-232 interface. Every individual data transfer is triggered by the PC/PLC by way of command no. 18. Upon this request the sensor sends a single data frame (36 byte) to the PC/PLC.

**EXT-IN0 L/H TRIGG:**

A single data frame (36 byte) is sent to the PC/PLC with every LOW/HIGH edge at digital input IN0/pin3/green.



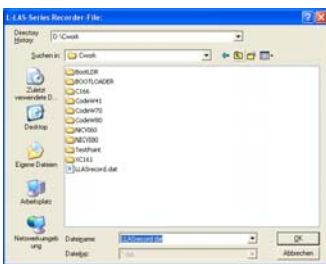
**TIME-INTERVAL [sec]:**

This numeric input field can be used to set a time interval in seconds. When this time interval is over, the PC software automatically requests measurement data from the sensor (command 18).



**SAMPLES [MAX 32000]:**

Numeric input field for presetting the maximum number of measurement values that should be saved. The value range is 10 to 32000.

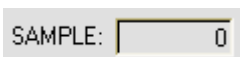


**FILE button**

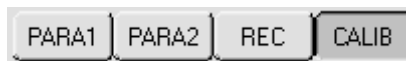
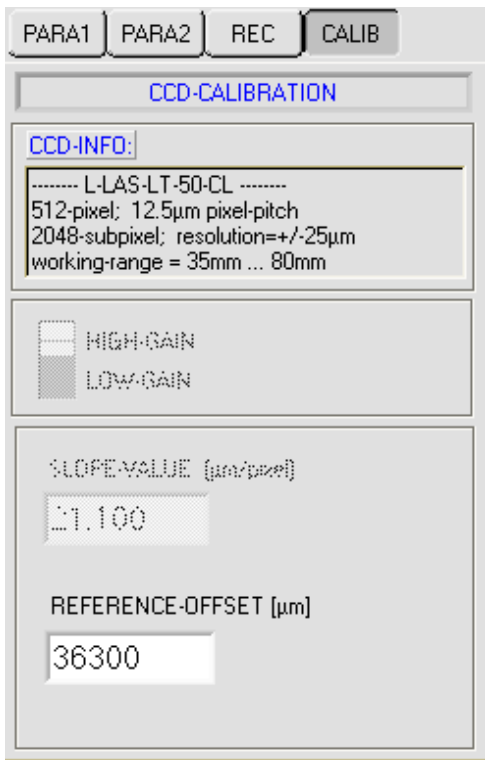
A click on the FILE button opens a new dialog window for entering the file name and setting the directory for the output file. The currently selected directory and the file name of the output file are shown in a text display beside the FILE button.



Automatic recording can be started by pressing the START button. If recording should be stopped before the maximum number defined by SAMPLES is reached, this can be done by clicking on the STOP button.



Numeric display field showing the current number of read measurement values.



A click on the CALIB button opens the CCD-CALIBRATION window on the user interface.



Attention!



**Changes that are made in the function fields described below only become active at the control unit of the *L-LAS-LT* sensor after a click on the SEND button!**



#### CCD-INFO:

After a click on the CONNECT function field, information about the currently detected sensor hardware is automatically exchanged through the serial RS-232 interface. This hardware information is shown in the CCD-INFO text field.

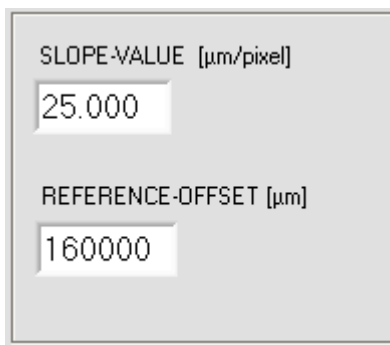


#### CCD-GAIN [1]:

Binary switch for setting the gain at the CCD line.

Please note:

This function is not available with all the *L-LAS-LT* sensors.



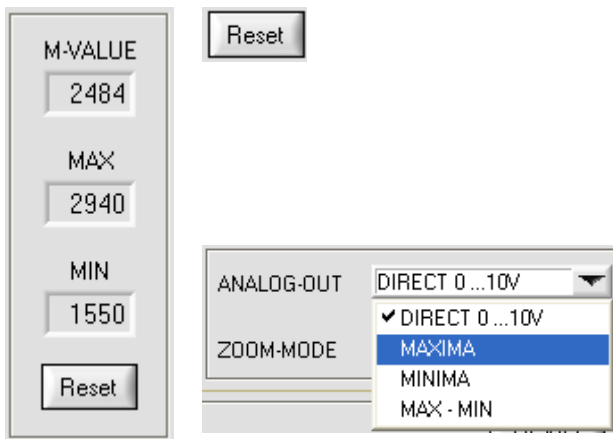
#### SLOPE-VALUE [µm/pixel]:

Numerical input field for setting the sensitivity of the *L-LAS-LT* sensor. The numerical value that is set here determines how many micrometers of distance correspond with a pixel.

#### REFERENCE-OFFSET [µm]:

Numerical input field for setting any desired offset value. If, for example, the *L-LAS-LT-200* sensor is used for determining the distance to the measuring object, the offset value is 160000µm = 160mm. The offset value is added to the CCD-line value to derive the measurement value in mm.

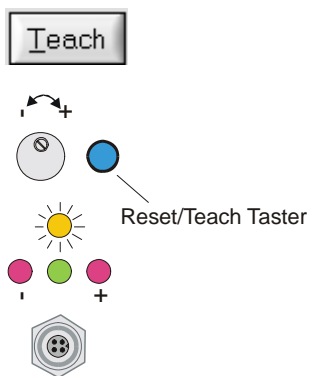
[1] This function is not available for all sensor types



**RESET button:**

The current drag pointer values of maximum and minimum value determination can be reset with the RESET button.

The current maximum value MAX and the current minimum value MIN since the last RESET each are shown in a numeric display field. The numeric values that are shown here are pixel values. The current measurement value in pixels is shown in the display field labelled M-VALUE. These numeric display elements only are shown in analog output mode ANALOG-OUT: MAXIMA, MINIMA or MAX-MIN.



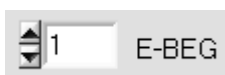
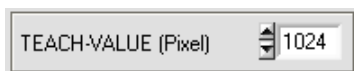
**TEACH button [1]:**

A click on the TEACH button starts a teach process at the *L-LAS-LT sensor*. The position of the intensity maxima at the *L-LAS-LT sensor* is evaluated and, depending on the evaluation mode, the calculated value is written to the volatile RAM memory of the control unit as a teach value.

When the teach process is completed the yellow LED at the housing of the *L-LAS-LT sensor* shortly blinks 3 times.

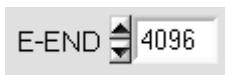
The teach process also can be started by means of the TEACH/RESET button at the housing (pressing the button for  $t > 1.5s$ ) or by way of a HIGH pulse at digital input IN1/yellow/pin4 of at least 1.5s length.

As an alternative the current teach value (setpoint value) also can be set by entering a numerical value in the numeric input field. The teach value that is set by this method will only be activated at the *L-LAS-LT sensor* after a click on the SEND button.



**E-BEG:**

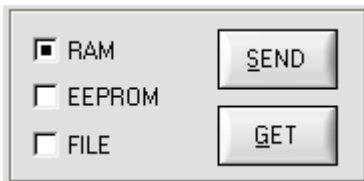
Numeric input field for entering the beginning of evaluation. The CCD line is evaluated starting from the pixel that is set here (Evaluation-Begin). (Default value = 1). The analog information of the pixels lying left of E-BEG is not used for evaluation.



**E-END:**

Numeric input field for entering the end of evaluation. The intensity information at the CCD line is evaluated up to this pixel. Pixels lying on the right side of the pixel value that is set here will not be evaluated.

[1] This function is not available for “Compact Line” sensor types (“-CL”)



### PARAMETER TRANSFER:

This group of function buttons is used for transferring parameters between the PC and the *L-LAS-LT control unit* through the serial RS232 interface.



#### SEND:

When the SEND button is clicked, the parameters currently set on the user interface are transferred to the *L-LAS-LT control unit*. The target of data transfer is determined by the selected radio-button (RAM, EEPROM, or FILE).



#### GET:

When the GET button is clicked, the setting parameters are transferred from the *L-LAS-LT control unit* to the PC and are updated on the user interface. The source of data transfer again is determined by the selected radio-button:

#### RAM:

The currently set parameters are written to the volatile RAM memory of the *L-LAS-LT control unit*, or they are read from the RAM and transferred to the PC. Please note: The parameters set in the RAM will be lost when the power supply at the *L-LAS-LT control unit* is turned off.

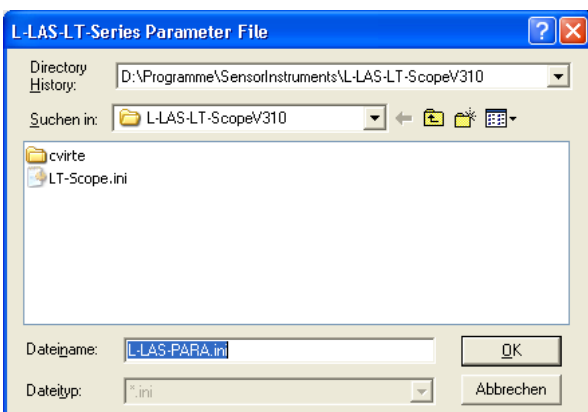
#### EEPROM:

The currently set parameters are written to the non-volatile EEPROM memory of the *L-LAS-LT control unit*, or they are read from the EEPROM and transferred to the PC. Parameters that are saved in the EEPROM will not be lost when the power supply is turned off.

If parameters are read from the EEPROM of the *L-LAS-LT control unit*, these must be written to the RAM of the *L-LAS-LT control unit* by selecting the RAM button and then clicking on SEND. The *L-LAS-LT control unit* then continues to operate with the set RAM parameters.

#### FILE:

When the FILE radio-button is selected, a click on the SEND/GET button opens a new file dialog on the user interface. The current parameters can be written to a freely selectable file on the hard disk of the PC, or parameters can be read from such a file.



### FILE dialog window:

The standard output file for the parameter values has the file name "LLASpara.cfg".

The output file can be opened e.g. with the standard Windows text editor program "EDITOR".

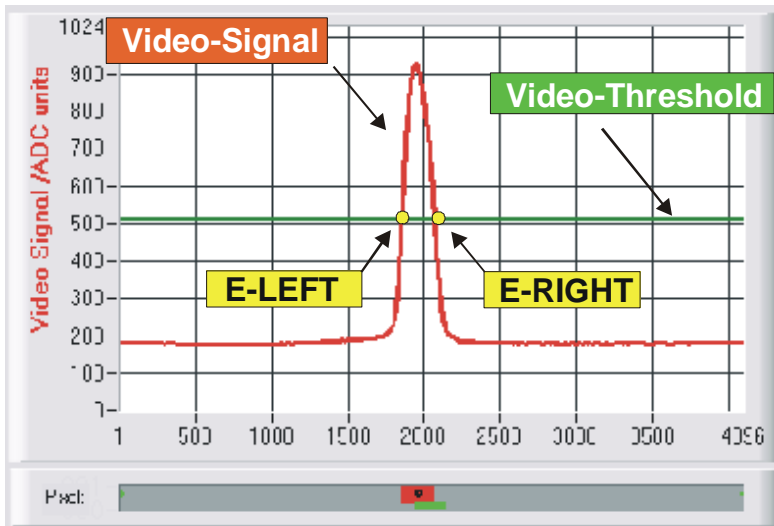


### 3.2 Numeric and graphic display elements:



**VIDEO button:**

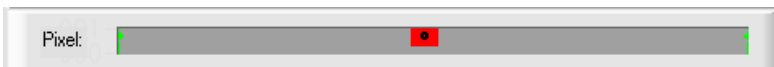
After a click on the VIDEO button, the intensity profile measured at the CCD receiver is transferred to the PC and shown as a red curve in the graphic display window.



The y-axis shows the analog signals of the individual pixels. The analog values (video signals) of the CCD line are converted by means of an AD converter with 10-bit resolution, which results in a y-axis value range of 0 .. 1024. The currently set video threshold (V-THD) is shown as a green horizontal line in the graphic window.

The intensity maximum results from the optical representation of the laser light that is scattered back from the measuring object.

The edge values (pixels) are derived from the intersection points of the intensity profile (red curve) with the video threshold (green line). The x-axis shows the pixels of the CCD line (e.g.: pixel: 1 .. 4096). Because of the limited data transfer rate of the serial interface (19200 Baud/s) the graphic display window can only be updated every second.



Beneath the graphic display window there is another display element that shows the currently detected shadowed areas (gray) and the illuminated areas (red) of the CCD line. Furthermore the currently detected edge position is indicated by way of a black point-shaped circle.



**E-LEFT:**

Numeric display field that shows the current pixel position of the left bright/dark transition that is calculated from the intensity profile (red curve) of the CCD line.



**E-RIGHT:**

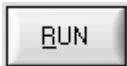
Numeric display field that shows the current pixel position of the right bright/dark transition that is calculated from the intensity profile (red curve) of the CCD line.



**MEASUREMENT-VALUE:**

Numeric display field that shows the current measurement value (depending on the set evaluation mode). The left numeric display field shows the current measurement value in pixels, whereas the right display field shows the measurement value converted into millimetres.

If the current measurement value lies within the tolerance band around the teach value, the display fields are shown with a green background. If the measurement value lies outside the tolerance band, the display elements are shown with a red background. The measurement value in pixels or in [mm] does not directly result from the pixel edge values E-LEFT and E-RIGHT, it is rather the measurement values linearised by way of a conversion table that are output.



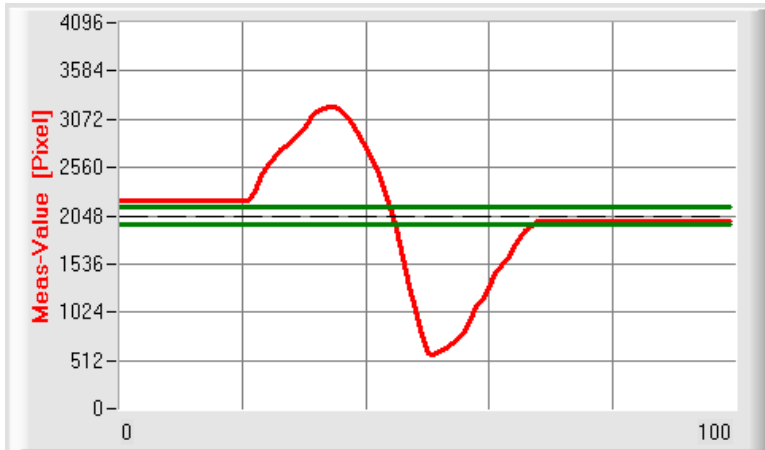
**RUN button:**

After a click on the RUN button, the current measurement data will be transferred from the L-LAS-LT sensor to the PC via the serial interface. A click on the STOP button terminates the data transfer.



**STOP button:**

A mouse-click on the STOP button terminates the data transfer between *L-LAS-LT sensor* and PC.



After a click on the RUN button the current measurement value is shown in the graphic display window in "scroll mode".

In the form of a red curve the measurement values pass through the graphic display window from right to left.

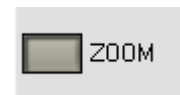
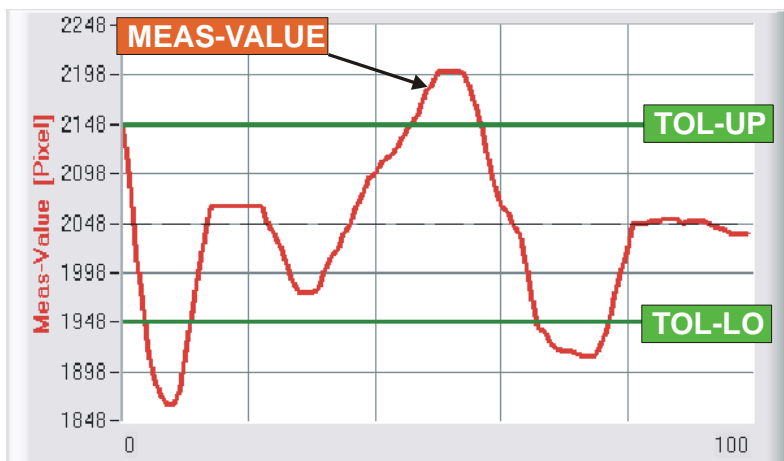
The y-axis graduation corresponds with the pixels or sub-pixels on the CCD line. The most recent measurement value is shown at the right end of the graphic display at x-value = 100.

The currently set setpoint value (TEACH value) is shown as a broken horizontal line.

In addition, the currently set tolerance window is represented by two horizontal green lines that are applied symmetrically around the setpoint value.

The length of the data frame that is transferred through the serial interface in "RUN mode" is limited to 18 words (36 bytes), which allows faster updating of the numeric and graphic display elements.

Compared to "VIDEO mode", data transfer through the serial RS232 interface therefore does not take so much time (in VIDEO mode the intensity information for every pixel must be transferred).



A click on the ZOOM button automatically rescales the y-axis in the graphic display window, which means that the changes of the measurement value can be displayed more clearly.

The picture here shows the time characteristic of the measurement value change as a red curve, and the tolerance band as two green lines. The teach value is shown as a broken horizontal line.

### 3.3 Serial RS232 data transfer:

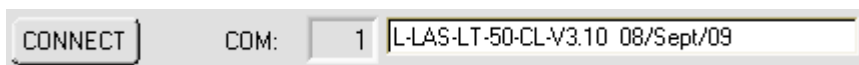
#### RS232 COMMUNICATION:

- Standard RS232 serial interface without hardware-handshake.
- 3-line-connection: GND, TXD, RXD.
- Speed: 19200 baud, 8 data bits, no parity bit, 1 stop bit in binary mode, MSB first.



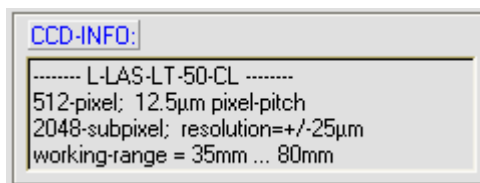
**Attention !**

The stable function of the RS232 interface (status message after program start) is a basic prerequisite for data transfer between the PC and the *L-LAS-LT control unit*. Due to the low data transfer rate of the serial RS232 interface (19200 bit/s) only slow changes of the analog values can be observed in the graphic display at the PC. In order to guarantee the maximum switching frequency of the *L-LAS-LT control unit* it is therefore necessary to stop the data transfer during the normal monitoring process (click on the STOP button).



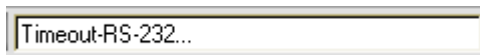
#### CONNECT:

When the software is started, it attempts to establish a connection to the *L-LAS-LT control unit* through the standard COM1 interface. If connection could be established successfully, the current firmware version is displayed in the status line.



The CCD-INFO field furthermore shows the sensor type that was detected by the software, and other identification data.

If another sensor type of the *L-LAS-LT-series* is connected via the RS-232 interface, it is imperative that the CONNECT function field is selected again to make sure that the current sensor type can be properly detected by the PC software.

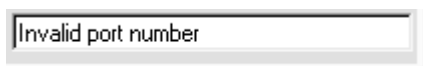


The serial connection between the PC and the *L-LAS-LT control unit* could not be established, or the connection is faulty.



**In this case it should first be checked whether the *L-LAS-LT control unit* is connected to the power supply, and whether the serial interface cable is correctly connected to PC and control unit.**

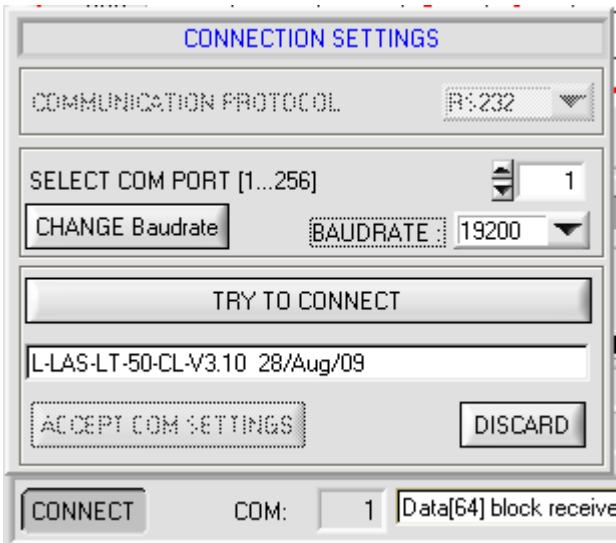
If the number of the serial interface that is assigned at the PC should not be known, interface COM1 to COM9 can be selected by using the CONNECT drop-down list.



If there is an “Invalid port number” status message, the selected interface (e.g. COM2) is not available at your PC.

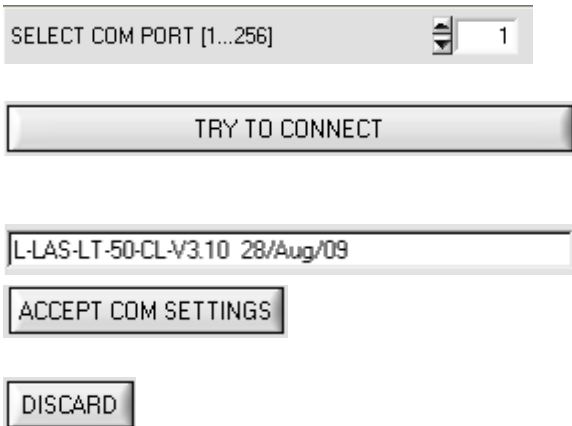


If there is a “Cannot open port” status message, the selected interface (e.g. COM2) may already be used by another device.



**CONNECT-Taste:**

A click on the CONNECT button opens a popup window where various settings for the serial interface can be made.



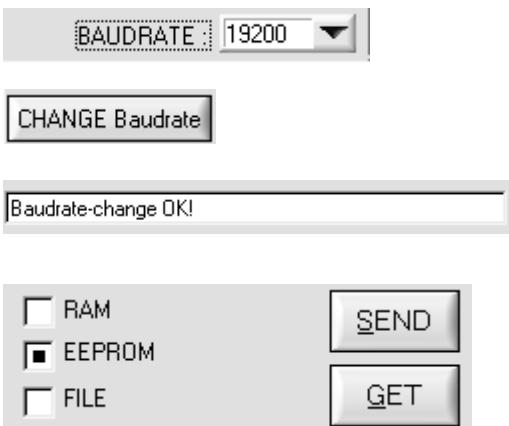
Setting of the current COM port number. Possible value range: 1...256.

After a click on this button the software tries to establish a connection with the sensor hardware by way of the currently set baud rate and the currently set COM port.

If connection could be successfully established, a firmware status message is displayed in the status line.

A click on the ACCEPT COM SETTINGS button saves the current settings in the *L-LAS-LT-Scope* PC software. The popup window will then be closed.

A click on the DISCARD button closes the CONNECT popup window without saving any new values. The settings for baud rate and COM port number are reset to the previous values.



Baud rate setting at the sensor: Possible setting values are 9600Baud, 19200Baud, 38400Baud, 57600Baud or 115200 Baud.

The baud rate will only be changed at the sensor hardware when the CHANGE Baudrate button is pressed. When the baud rate change at the sensor was successful, a corresponding status message will be displayed.

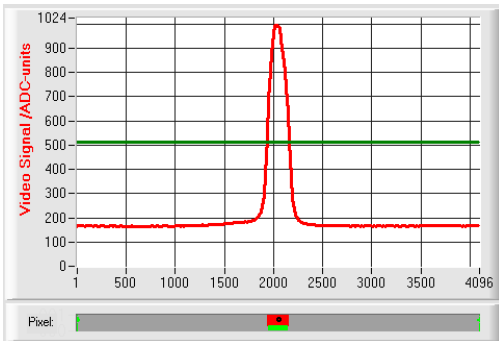
The baud rate change is performed in the volatile RAM memory of the sensor. If the baud rate should be permanently stored, it must be written to the sensor's EEPROM memory. To do this, select EE and press the SEND button.

### 3.4 L-LAS-LT-Scope as an aid for sensor adjustment:



#### VIDEO:

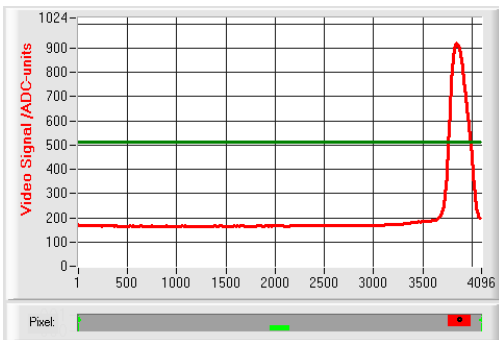
After a click on the VIDEO button, fine adjustment of the sensors relative to the measuring object can be done in the graphic display window. Because of the limited data transfer rate of the RS232 interface the display window can only be updated every second.



#### Adjustment OK - centered

In the graphic display window the intensity profile is shown as a red curve. The numerical values 1 ... 4096 on the x-axis represent the individual pixels of the CCD line.

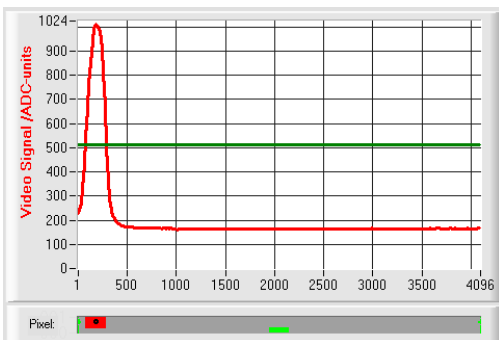
The intensity maximum approx. lies at pixel 2048. The *L-LAS-LT sensor* thus is optimally adjusted at the centre of the measuring range.



#### Upper measuring range limit reached:

The distance of the *L-LAS-LT sensor* from the measuring object almost is too large. The intensity maximum lies at pixel values close to 4000.

The distance between the *L-LAS-LT sensor* and the measuring object should be reduced.

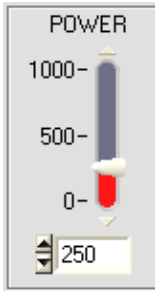


#### Lower measuring range limit reached

The distance of the *L-LAS-LT sensor* from the measuring object almost is too small. The intensity maximum lies at pixel values close to 1.

The distance between the *L-LAS-LT sensor* and the measuring object should be increased.

### 3.5 L-LAS-LT-Scope as an aid for transmitter power adjustment:

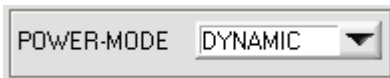


#### POWER:

The laser power at the laser transmitter unit of the *L-LAS-LT sensor* can be set by using the POWER slider or by entering a numerical value in the respective input field.



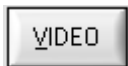
The laser power at the transmitter unit of the *L-LAS-LT sensor* is only updated when the SEND button is pressed.



#### DYNAMIC:

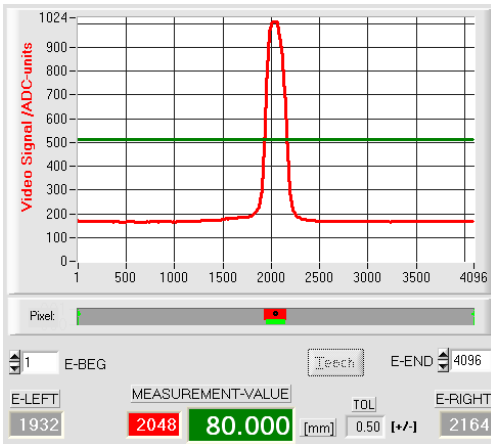
When the power mode is set to DYNAMIC, the laser power at the *L-LAS-LT sensor* is automatically regulated. This means that the laser power is regulated in such a way that the maximum values of the "intensity peaks" approx. lie at 80-90% of the analog dynamic range.

**Settings at the POWER slider have no effect in this operating mode! --- This mode is recommended as the standard mode! ---**



#### VIDEO:

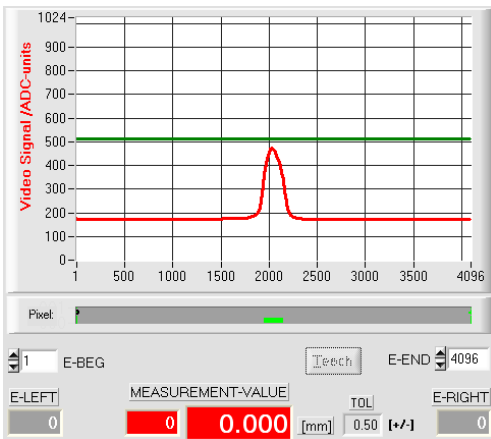
After a click on the VIDEO button, the current intensity profile is transferred from the *L-LAS-LT sensor* to the PC and is shown as a red curve in the graphic display window.



#### Optimum transmitter power:

In the whole measuring range (pixel 1 ... 4096) the maximum of the intensity characteristic should be clearly above the video threshold (green line).

The measurement values can be calculated from the intersection points of the intensity profile with the video threshold:



#### Transmitter power too low:

The intensity profile (red curve) at the CCD receiver is too low. The maximum values lie below the video threshold (green horizontal line).

No bright/dark transition (intersection point between red and green curve) can be detected.

The calculated measurement value therefore = 0!



## 4 Evaluation modes

### 4.1 LEFT-EDGE:



The left intersection point (bright/dark transition) at the intensity maximum is used as the measurement value.

$$MVAL[pixel] = E\_LEFT \quad \text{here: } 1052$$

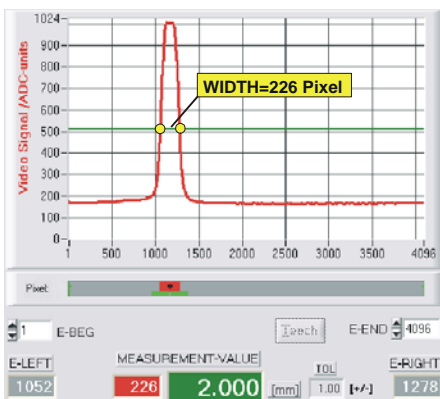
### 4.2 RIGHT-EDGE



The right intersection point (bright/dark transition) at the intensity maximum is used as the measurement value.

$$MVAL[pixel] = E\_RIGHT \quad \text{here: } 1278$$

### 4.3 WIDTH

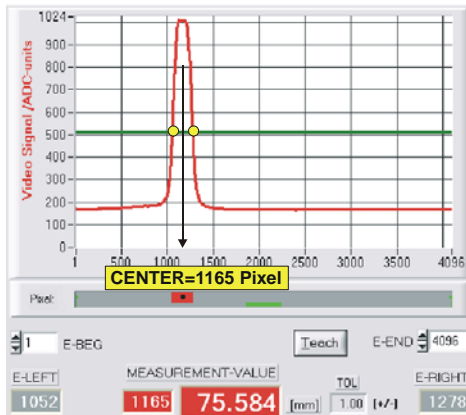


The width of the intensity maximum is calculated from the intersection points of the intensity profile (red curve) with the video threshold (green line).

$$MVAL[pixel] = E\_RIGHT - E\_LEFT$$

here:  $MVAL = 226 = 1278 - 1052$

#### 4.4 CENTER



The center position of the intensity maximum is calculated from the intersection points of the intensity profile (red curve) with the video threshold (green line).

$$MVAL[\text{pixel}] = (E\_RIGHT + E\_LEFT) / 2$$

here:  $MVAL = 1165 = (1278 + 1052) / 2$

**EVAL-MODE CENTER should be set as the standard mode at the line sensor.**



## 5 Data recorder function

APPEND TO DATA-FILE...

RS-232-MODE STATIC

TIME-INTERVAL [sec] 1.00

SAMPLES [MAX 32000] 100

DAYS:	HOURS:	MIN:	SEC:
0	0	0	10

START DATE:	START TIME:
09-08-2009	15:19:28

<div style="border: 1px solid gray; padding: 2px; display: inline-block;">▶</div> <div style="border: 1px solid gray; padding: 2px; display: inline-block; margin-left: 10px;">✖</div>	SAMPLE: <span style="border: 1px solid gray; padding: 2px;">10</span>
--	---

<div style="border: 1px solid gray; padding: 2px; display: inline-block;">📁</div>	d:\Programme\RECORD.DAT
---	-------------------------

PARA1
PARA2
REC
CALIB

A click on the REC button opens the DATA-RECORDER window on the user interface.

RS-232-MODE STATIC

### RS-232-MODE:

Drop-down function field for setting the data request at the L-LAS-sensor hardware.

### STATIC:

The sensor does not automatically send measurement data via the RS-232 interface. Every individual data transfer is triggered by the PC/PLC by way of command no. 18. Upon this request the sensor sends a single data frame (36 byte) to the PC/PLC.

### EXT-IN0 L/H TRIGG:

A single data frame (36 byte) is sent to the PC/PLC with every LOW/HIGH edge at digital input IN0/pin3/green.

TIME-INTERVAL [sec] 1.00

### TIME-INTERVAL [sec]:

This numeric input field can be used to set a time interval in seconds. When this time interval is over, the PC software automatically requests measurement data from the sensor (command 18). The PC/PLC waits until the complete data frame (36 byte) from the sensor has arrived in the input buffer of the serial interface of the PC. Then the PC saves the new measurement data in an output file on the hard disk. Minimum value: 0.1 [sec]. When the TIME-INTERVAL [sec] is over, the PC/PLC initiates a new transfer.

SAMPLES [MAX 32000] 100

### SAMPLES [MAX 32000]:

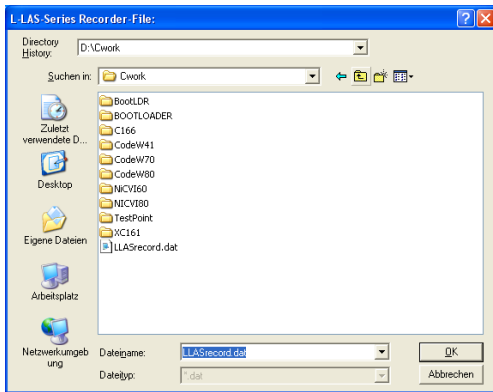
Numeric input field for setting the maximum number of measurement values that should be stored. The value range is from 10 to 32000.

START DATE:	START TIME:
02-06-2008	16:48:31

Numeric display fields providing information about the start date and the start time. These displays will be updated when the START button is pressed.

DAYS:	HOURS:	MIN:	SEC:
0	0	1	40

Numeric display elements showing the time in seconds that has passed since the recorder function has been activated.



### FILE-Taste

A click on the File button opens a dialog for entering the file name and the target directory of the output file.

The currently selected target directory and file name of the output file are shown in the text display below.

d:\Programme\RECORD.DAT



START



STOP

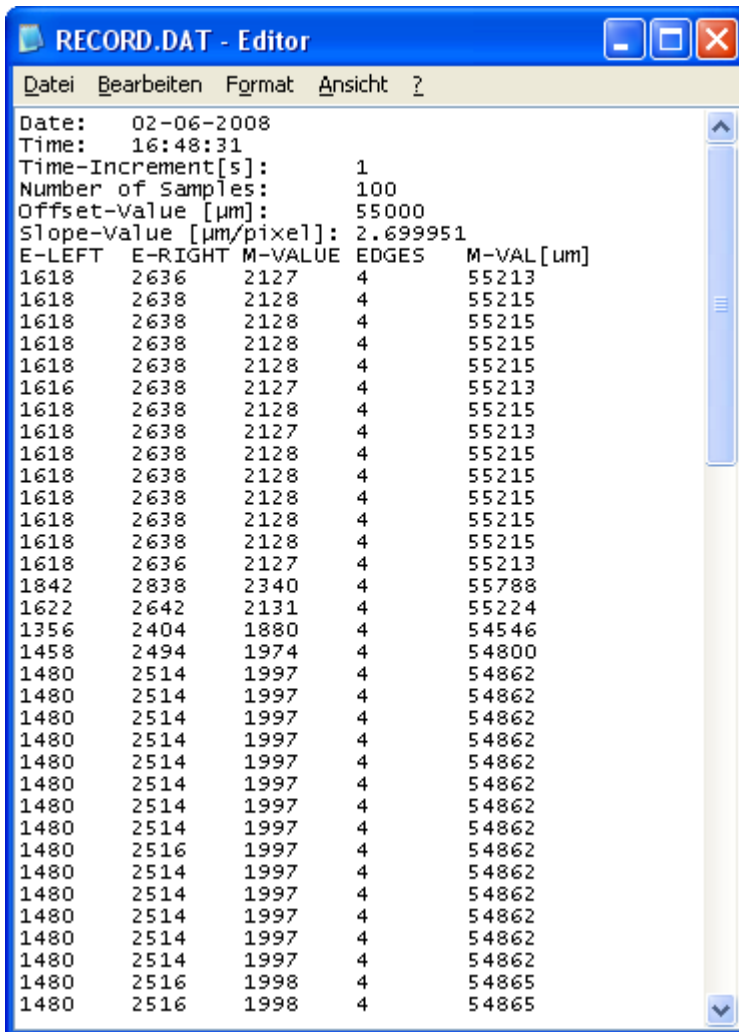
Automatic recording can be started by pressing the START button. With a click on the STOP button recording can be stopped before the maximum number set in SAMPLES is reached.

SAMPLE:

Numeric display field shown the current number of read measurement values.

## 5.1 Data format of the output file

The output file of the data recorder consists of 7 header lines, followed by the actual measurement data. The measurement data are written to the output file line-by-line. Each line comprises 5 columns that are separated from each other by a TAB control character. The output file can be opened with a simple text editor or a spreadsheet program (e.g. Microsoft EXCEL).




```

RECORD.DAT - Editor
Datei Bearbeiten Format Ansicht ?
Date: 02-06-2008
Time: 16:48:31
Time-Increment[s]: 1
Number of Samples: 100
Offset-value [µm]: 55000
Slope-value [µm/pixel]: 2.699951
E-LEFT E-RIGHT M-VALUE EDGES M-VAL [µm]
1618 2636 2127 4 55213
1618 2638 2128 4 55215
1618 2638 2128 4 55215
1618 2638 2128 4 55215
1618 2638 2128 4 55215
1616 2638 2127 4 55213
1618 2638 2128 4 55215
1618 2638 2127 4 55213
1618 2638 2128 4 55215
1618 2638 2128 4 55215
1618 2638 2128 4 55215
1618 2638 2128 4 55215
1618 2638 2128 4 55215
1618 2638 2128 4 55215
1618 2638 2128 4 55215
1618 2638 2128 4 55215
1842 2838 2340 4 55788
1622 2642 2131 4 55224
1356 2404 1880 4 54546
1458 2494 1974 4 54800
1480 2514 1997 4 54862
1480 2514 1997 4 54862
1480 2514 1997 4 54862
1480 2514 1997 4 54862
1480 2514 1997 4 54862
1480 2514 1997 4 54862
1480 2514 1997 4 54862
1480 2514 1997 4 54862
1480 2514 1997 4 54862
1480 2514 1997 4 54862
1480 2514 1997 4 54862
1480 2514 1997 4 54862
1480 2514 1997 4 54862
1480 2514 1997 4 54862
1480 2514 1997 4 54862
1480 2516 1998 4 54865
1480 2516 1998 4 54865
    
```

- 1st column = Measurement value (pixel) E-LEFT
- 2nd column = Measurement value (pixel) E-RIGHT
- 3rd column = Measurement value (pixel) M-VALUE
- 4th column = Number of edges
- 5th column = Measurement value (micrometers)

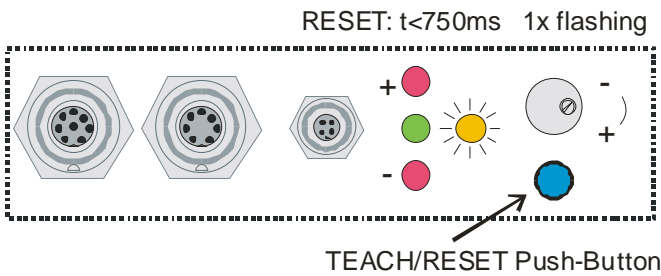
## 6 Annex

### 6.1 Laser warning

<b>LASER WARNING</b>	
<p>Solid-state laser, <math>\lambda=670</math> nm, 1mW max. optical power, laser class 2 acc. to EN 60825-1</p> <p>Therefore no additional protective measures are required for the use of these laser transmitters.</p>	
	<div style="border: 2px solid black; background-color: yellow; padding: 5px; width: fit-content; margin: 0 auto;"> <p style="text-align: center; margin: 0;">Nicht in den Strahl blicken Laser Klasse 2</p> </div>

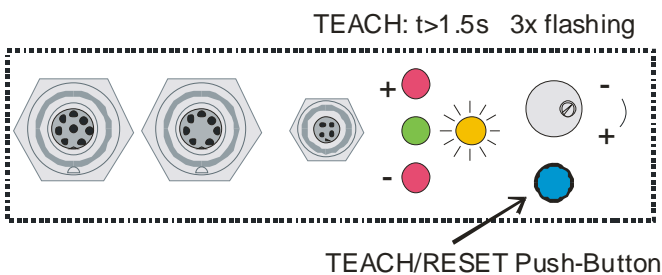
### 6.2 Function of the TEACH/RESET button [1]:

The housing of the *L-LAS-LT* sensor features a pushbutton with two functions:



#### RESET function:

When the button is pressed for a short time ( $t < 750\text{ms}$ ) the current maximum and minimum values (drag pointer values) are reset. This does not perform a hardware/software RESET!

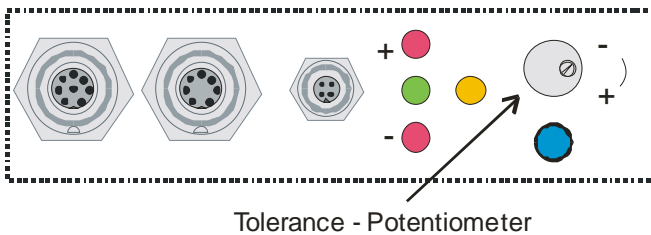


#### TEACH function:

When the button is pressed for a longer time ( $t > 1.5\text{s}$ ), the current edge coverings are stored as teach value in the RAM memory. When the teach process has been performed successfully, the green LED flashes three times.

### 6.3 Function of the tolerance potentiometer [1]:

The housing of the *L-LAS-LT* sensor features a potentiometer for setting the tolerance band width.



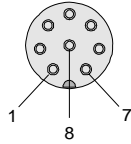
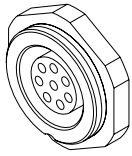
#### TOLERANCE potentiometer:

Turning the potentiometer clockwise increases the tolerance band width. Turning it counter-clockwise decreases the tolerance band width. The potentiometer must be activated in order to use it for setting the tolerance band width at the *L-LAS-LT* sensor (switch HW-MODE to position ENABLE ALL or ENABLE TOL SET).

[1] This function is not available for "Compact Line" sensor types ("-CL")

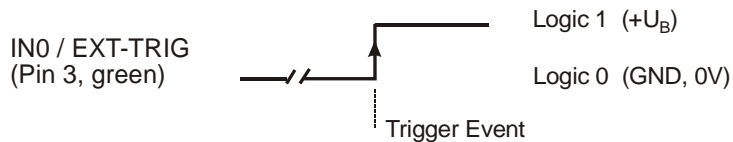
## 6.4 Function of digital inputs IN0 and IN1

The *L-LAS-LT sensor* has two digital inputs IN0 and IN1 that can be contacted through the 8-pole female connector (type Binder 712).

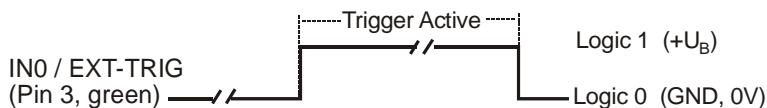


Pin:	Colour:	Assignment:
1	white	0V (GND)
2	brown	+15VDC ... +30VDC (+U <sub>B</sub> )
3	green	<b>IN0 (EXT TRIGGER)</b>
4	yellow	<b>IN1 (TEACH/RESET)</b>
5	gray	OUT0
6	pink	OUT1
7	blue	OUT2
8	red	ANALOG (0 ... +10V)

### DIGITAL INPUT IN0 (pin3/green) EXT-TRIGGER:



External edge-controlled (LOW/HIGH) triggering of measurement value evaluation through digital input IN0.

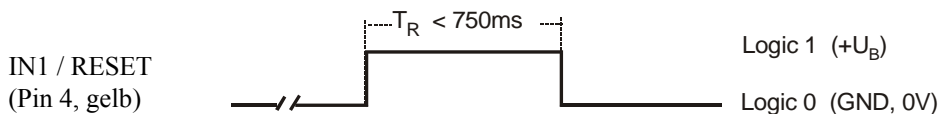


External triggering of measurement value evaluation through a HIGH level (+U<sub>B</sub>) at digital input IN0.

### DIGITAL INPUT IN1 (pin4/yellow) TEACH/RESET:

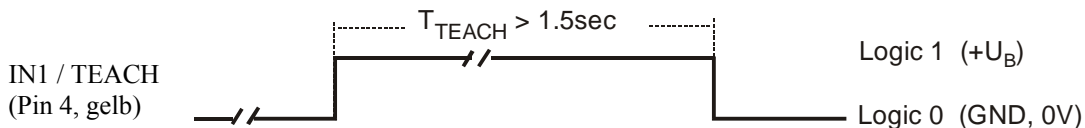
#### RESET function:

When a HIGH pulse of less than **750 ms** duration is applied, the RESET function is performed at the *L-LAS-LT sensor*. This resets the current maximum and minimum values (drag pointer). A hardware/software RESET is not performed! When a RESET pulse has been detected, the yellow LED flashes shortly one time.

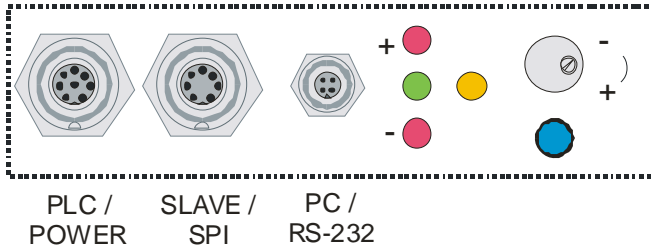


#### TEACH function:

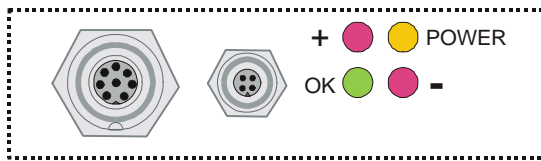
When a HIGH pulse of more than **1.5s** duration is applied, the TEACH function is performed at the *L-LAS-LT sensor*. When a TEACH pulse has been detected, the green LED at the housing flashes shortly three times.



## 6.5 Connector assignment



PLC / POWER    SLAVE / SPI    PC / RS-232



SPS / POWER    PC / RS-232

### STANDARD TYPE:

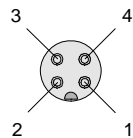
At the housing of the *L-LAS-LT sensor* there is a female connector for power supply connection (8-pole type Binder 712), a 7-pole female connector (type Binder 712) for connection of the SLAVE sensor, and a third female connector for connecting a serial RS232 connecting cable (4-pole type Binder 707).

### COMPACT LINE (CL) TYPE:

The housing of the *Compact-Line sensor* features an 8-pole socket for power supply connection (type Binder 712) and a 4-pole socket for connecting the serial RS232 connecting cable (type Binder 707).

### RS232 connection to PC:

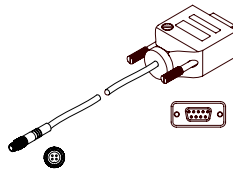
4-pole M5 female connector type Binder 707



Pin:	Assignment:
1	+24V (+Ub, OUT)
2	0V (GND)
3	RxD
4	TxD

### Connecting cable:

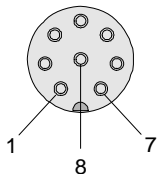
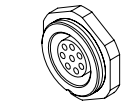
cab-las4/PC (length 2m, cable jacket: PUR)



### Interface to PLC / power supply:

8-pole female connector type Binder 712

#### Standard type:



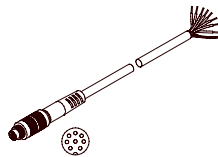
Pin:	Color:	Assignment:
1	white	0V (GND)
2	brown	+15VDC ... +30VDC (+Ub)
3	green	IN0 (EXT TRIGGER)
4	yellow	IN1 (TEACH/RESET)
5	grey	OUT0 (-)
6	pink	OUT1 (+)
7	blue	OUT2 (OK)
8	red	ANALOG (0 ... +10V)

#### Compact Line (CL) type:

Pin:	Color:	Assignment:
1	white	0V (GND)
2	brown	+15VDC ... +30VDC (+Ub)
3	green	IN0 (EXT TRIGGER)
4	yellow	IN1 (TEACH/RESET)
5	grey	OUT0 (-)
6	pink	OUT1 (+)
7	blue	0V (GND) or 4 ... 20mA
8	red	ANALOG (0 ... +10V)

### Connecting cable:

cab-las8/SPS (length 2m, cable jacket: PUR)



## 6.6 RS-232 interface protocol

### RS232 interface protocol PC ↔ L-LAS-LT Sensor Firmware Version 3.1x

- Standard RS232 serial interface, no hardware handshake
- 3-line connection: GND, TX0, RX0
- Speed: 9600 Baud, 19200 Baud, 38400 Baud, 57600 Baud, or 115200 Baud
- 8 data-bits
- No parity bit
- 1 stop-bit
- Binary mode.

The control device (PC or PLC) must send a data frame consisting of 18-words (1 word = 2 byte = 16 bit) to the L-LAS-LT control unit. All words in the data frame must be transferred in binary format. The higher-order byte must be transferred first (MSB-first).

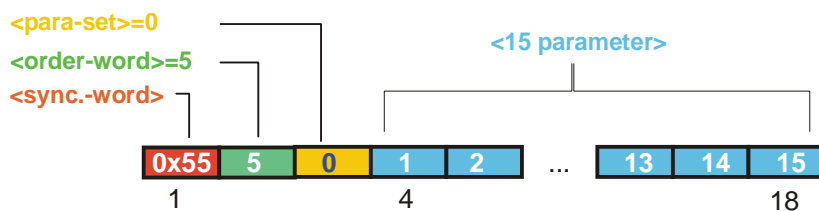
#### METHOD:

The microcontroller in the L-LAS-LT sensor permanently reads the input buffer of its RS-232 module (polling). If the arriving word is *0x0055* (0x55 hexadecimal = 85 decimal), this is interpreted as a synchronisation event: (**<sync-word>**). The microcontroller then reads the order number (**<order-word>**) that is transferred with the 2nd word.

After the order word (**<order-word>**) another word is transferred that informs about the number of the parameter set (**<para-set>**). This is followed by additional 15 words **<parameter-word>** that contain the actual parameters.

When the complete data frame (18 words = 36 bytes) has been read in, the L-LAS-LT control unit starts to execute the order contained in the 2nd word (**<order-word>**).

#### DATA FRAME: PC/PLC → SENSOR (18-Words=36Bytes, MSB first)



**Format of the data frame: <para-set = 0> STANDARD TYPE**

Word	Meaning	Comment
1	<sync-word>	hex-code 0x55, binary=0000 0000 0101 0101, dec.=85
2	<order-word>	Order word (see chart below)
3	<parameter-set> = 0	0 = Parameter set zero
4	POWER	Transmitter power (0 ... 1000)
5	POWER-MODE	Transmitter power mode: ( 0 = STATIC), (1=DYNAMIC)
6	POLARITY	Polarity for OUT0, OUT1,OUT2 (0=DIRECT, 1=INVERSE)
7	EVAL-MODE	Evaluation mode (0=L-EDGE, 1=R-EDGE, 2=WIDTH, 3=CENTER)
8	E-BEGIN	Beginning of the evaluation range, start pixel ( 1 .. E_END-1 )
9	E-END	End of the evaluation range, end pixel ( E_BEG+1 .. SUBPIXEL)
10	TEACH-VALUE	Teach value in pixels ( 1 ... SUBPIXEL)
11	TOLERANCE-HIGH VALUE	Upper tolerance value TOL-HIGH: (0 ... SUBPIXEL/2)
12	TOLERANCE-LOW-VALUE	Lower tolerance value TOL-LOW: (0 ... SUBPIXEL/2)
13	AVERAGE	Averaging ( 1,2,4,8,16,32,64,128 oder 256 )
14	TRIGG-MODE	Trigger mode (0=CONTINUOUS, 1=EXT. IN0 L/H, 2=EXT.IN0 HIGH)
15	ANALOG-OUT	Operating mode of the analog output: (0=DIRECT 0..10V, 1=MAXIMA, 2=MINIMA, 3=MAX-MIN)
16	OPERATION-MODE	Operating mode of the CCD line (0=LOW-GAIN / 1=HIGH-GAIN)
17	HW-MODE	Operating mode of hardware button and potentiometer (DISABLE-ALL=0, ENABLE-ALL=1,ENABLE-BTN=2, ENABLE POTI=3)
18	VIDEOTHD [%]	Video threshold (0 ... 100) in percent of the ADC range

**Format of the data frame: <para-set = 1> STANDARD TYPE**

Word	Meaning	Comment
1	<sync-word> = 0x0055	hex-code 0x55, binary=0000 0000 0101 0101, dec.=85
2	<order-word>	Order word (see chart below)
3	<parameter-set> = 1	1 = Parameter set one
4	TRIGG-THRESHOLD	0 , derzeit nicht verwendet
5	RS-232-MODE	Data recorder: 0 = STATIC, 1=EXT-IN0 L/H triggered
6	RS-232-BAUD	Baud rate: 0=9600, 1=19200, 2=38400, 3=57600 , 4=115200 Baud
7	ZOOM-MODE	Zoom function analog output: (0=DIRECT, 1=ZOOMx1, 2=ZOOMx2, 3=ZOOMx4, 4=ZOOMx8, 5=ZOOMx16, 6=WIN-5V, 7=WIN-10V)
8	Parameter 5	0 , presently not used
9	Parameter 6	0 , presently not used
10	Parameter 7	0 , presently not used
11	Parameter 8	0 , presently not used
12	Parameter 9	0 , presently not used
13	Parameter 10	0 , presently not used
14	Parameter 11	0 , presently not used
15	SLOPE VALUE L-WORD	Sensitivity of the sensor (x 1024), lower-order word
16	SLOPE VALUE H-WORD	Sensitivity of the sensor (x 1024), higher-order word
17	REF-OFFSET L-WORD	Reference offset in µm, lower-order word
18	REF-OFFSET H-WORD	Reference offset in um, higher-order word



**Format of the data frame: <para-set = 0> COMPACT LINE (-CL) TYPE**

Word	Meaning	Comment
1	<sync-word> = 0x0055	hex-code 0x55, binary=0000 0000 0101 0101, dec.=85
2	<order-word>	Order word (see chart below)
3	<parameter-set> = 0	0 = Parameter set zero
4	POWER	Transmitter power (0 ... 1000)
5	POWER-MODE	Transmitter power mode: ( 0 = STATIC), (1=DYNAMIC)
6	POLARITY	Polarity for OUT0, OUT1,OUT2 (0=DIRECT, 1=INVERSE)
7	EVAL-MODE	Evaluation mode (0=L-EDGE, 1=R-EDGE, 2=WIDTH, 3=CENTER)
8	E-BEGIN	Beginning of the evaluation range, start pixel ( 1 .. E_END-1 )
9	E-END	End of the evaluation range, end pixel ( E_BEG+1 .. SUBPIXEL)
10	TEACH-VALUE	Teach value in pixel ( 1 ... SUBPIXEL)
11	TOLERANCE-HIGH VALUE	Upper tolerance value TOL-HIGH: (0 ... SUBPIXEL/2)
12	TOLERANCE-LOW-VALUE	Lower tolerance value TOL-LOW: (0 ... SUBPIXEL/2)
13	AVERAGE	Averaging ( 1,2,4,8,16,32,64,128 oder 256 )
14	TRIGG-MODE	Trigger mode (0=CONTINUOUS, 1=EXT. IN0 L/H, 2=EXT.IN0 HIGH)
15	ANALOG-OUT	Operating mode of analog output: (0=DIRECT 0..10V, 1=MAXIMA, 2=MINIMA, 3=MAX-MIN)
16	ZOOM-MODE	Zoom function analog output: (0=DIRECT, 1=ZOOMx1, 2=ZOOMx2, 3=ZOOMx4, 4=ZOOMx8, 5=ZOOMx16, 6=WIN-5V, 7=WIN-10V)
17	VIDEOTHD [%]	Video threshold (0 ... 100) in percent of the ADC range
18	Parameter 15	0 , presently not used

**Format of the data frame: <para-set = 1> COMPACT LINE (-CL) TYPE**

Word	Meaning	Comment
1	<sync-word> = 0x0055	hex-code 0x55, binary=0000 0000 0101 0101, dec.=85
2	<order-word>	Order word (see chart below)
3	<parameter-set> = 1	1 = Parameter set one
4	TRIGG-THRESHOLD	0 , presently not used
5	RS-232-MODE	Data recorder: 0 = STATIC, 1=EXT-IN0 L/H triggered
6	RS-232-BAUD	Baud rate: 0=9600, 1=19200, 2=38400, 3=57600 , 4=115200 Baud
7	Parameter 4	0 , presently not used
8	Parameter 5	0 , presently not used
9	Parameter 6	0 , presently not used
10	Parameter 7	0 , presently not used
11	Parameter 8	0 , presently not used
12	Parameter 9	0 , presently not used
13	Parameter 10	0 , presently not used
14	Parameter 11	0 , presently not used
15	SLOPE VALUE L-WORD	Sensitivity of the sensor (x 1024), lower-order word
16	SLOPE VALUE H-WORD	Sensitivity of the sensor (x1024), higher-order word
17	REF-OFFSET L-WORD	Reference offset in $\mu\text{m}$ , lower-order word
18	REF-OFFSET H-WORD	Reference offset in $\mu\text{m}$ , higher-order word

**Meaning of the 2nd word in the data frame: <order-word>**

Wert	Meaning / Action	
<b>0</b>	Nop	no operation
<b>1</b>	Send parameters from PC to L-LAS-RAM	18 words, PC ⇒ L-LAS-RAM
<b>2</b>	Get parameters from L-LAS-RAM	18 words, L-LAS-RAM ⇒ PC
<b>3</b>	Send parameters from PC to EEPROM	18 words, PC ⇒ L-LAS-EEPROM
<b>4</b>	Get parameters from EEPROM of the L-LAS	18 words, L-LAS-EEPROM ⇒ PC
<b>5</b>	Echo check: Get Echo character from L-LAS	18 words, erstes Wort=0x00AA=170dec
<b>6</b>	Aktiviere teach process, store in RAM	18 words PC ⇒ L-LAS-RAM
<b>7</b>	Get firmware version message from L-LAS	72-bytes, L-LAS ⇒ PC
<b>8</b>	<b>Get measurement data from L-LAS-RAM</b>	<b>18 words, L-LAS-RAM ⇒ PC</b>
<b>9</b>	Get video buffer information from L-LAS	64 words, L-LAS-RAM ⇒ PC
<b>11</b>	Reset maxima/minima values	18 words PC ⇒ L-LAS-RAM
<b>18</b>	Get measurement data from L-LAS-RAM (recorder format)	18 words PC ⇒ L-LAS-RAM
<b>190</b>	Change RS232 baud rate	18 words PC ⇒ L-LAS-RAM

**Examples for data exchange:**

**Echo check: <order-word> = 5**

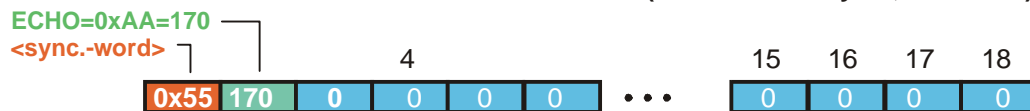
**<order-word> = 5**

Echo check: L-LAS-LT sensor sends echo: word=0x00AA=170 to PC

**DATA FRAME: PC → SENSOR (18-Words=36Bytes, MSB first)**



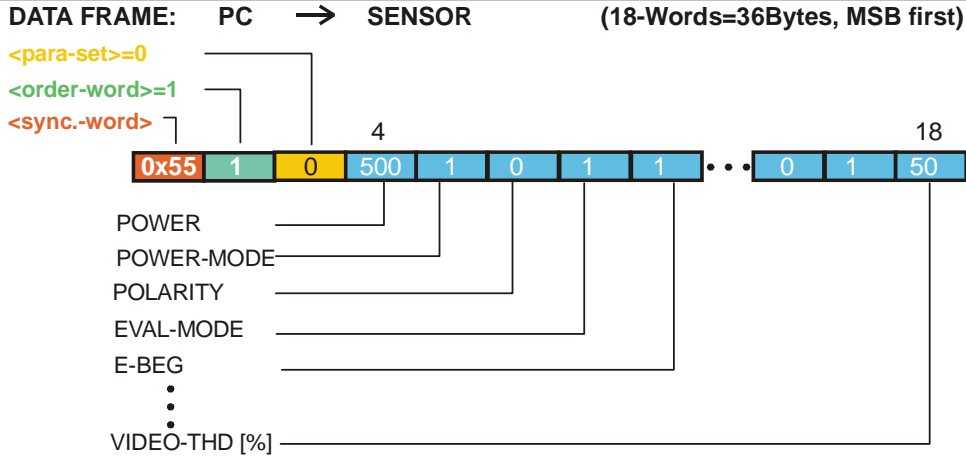
**DATA FRAME: SENSOR → PC (18-Words=36Bytes, MSB first)**



**SEND parameter set = 0 to L-LAS-RAM <order-word> = 1**

<order-word> = 1    <para-set> = 0

Send current parameters (SET=0) to RAM of L-LAS-LT sensor

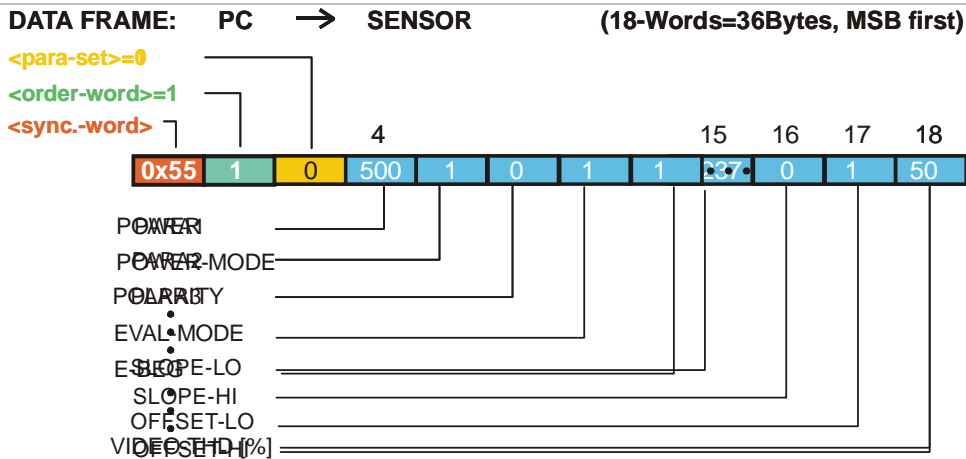


The transferred data frame automatically is sent back as an echo from the L-LAS-LT sensor!!

**SEND parameter set = 1 to L-LAS-RAM <order-word> = 1**

<order-word> = 1    <para-set> = 1

Send current parameters (SET=1) to RAM of L-LAS-LT sensor



SLOPE-VALUE is multiplied with x16384 e.g. 2.7[μm/pixel] x 16384 = 44237

OFFSET-VALUE in micrometer [μm] 55mm=55000[μm]

The transferred data frame automatically is sent back as an echo from the L-LAS-LT sensor!!



**Attention !**

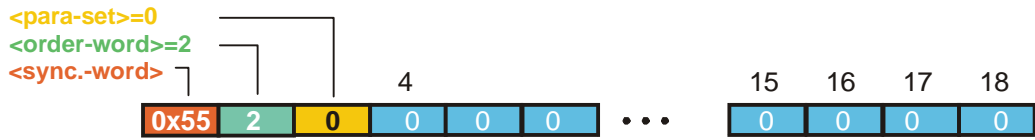
**For the final take-over of the full parameter set, both parameter sets (set=0 and set=1) must be transferred.**

**GET parameter set = 0 from L-LAS-RAM <order-word> = 2**

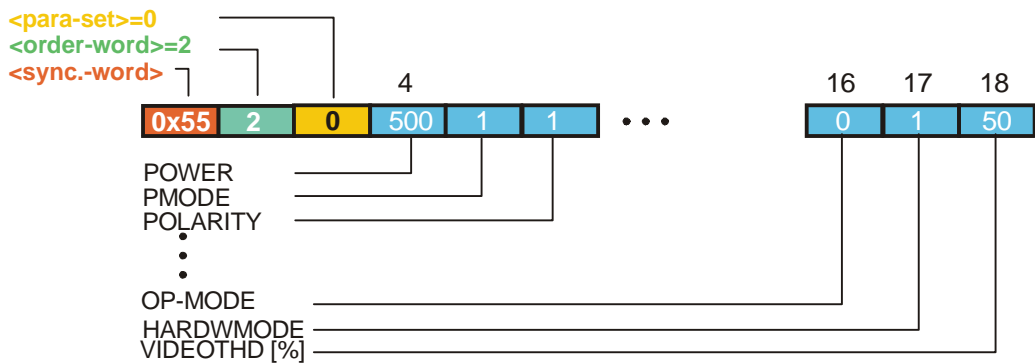
**<order-word> = 2**    **<para-set> = 0**

Get current RAM parameters (SET=0) from the L-LAS-RAM

**DATA FRAME: PC → SENSOR** (18-Words=36Bytes, MSB first)



**DATA FRAME: SENSOR → PC** (18-Words=36Bytes, MSB first)



**GET parameter set = 1 from L-LAS-RAM <order-word> = 2**

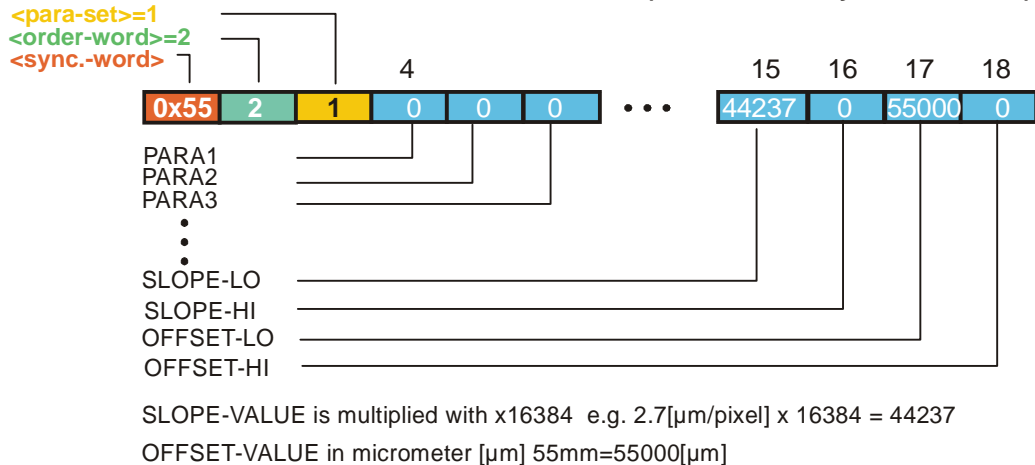
**<order-word> = 2**    **<para-set> = 1**

Get current RAM parameters (SET=1) from the L-LAS-RAM

**DATA FRAME: PC → SENSOR** (18-Words=36Bytes, MSB first)



**DATA FRAME: SENSOR → PC** (18-Words=36Bytes, MSB first)

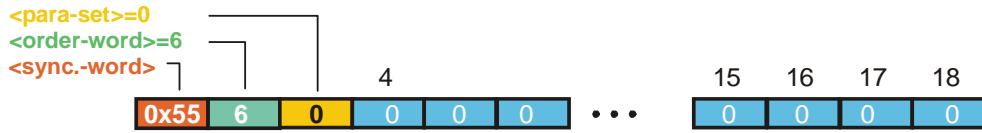


**Start the TEACH FUNCTION at the L-LAS <order-word> = 6**

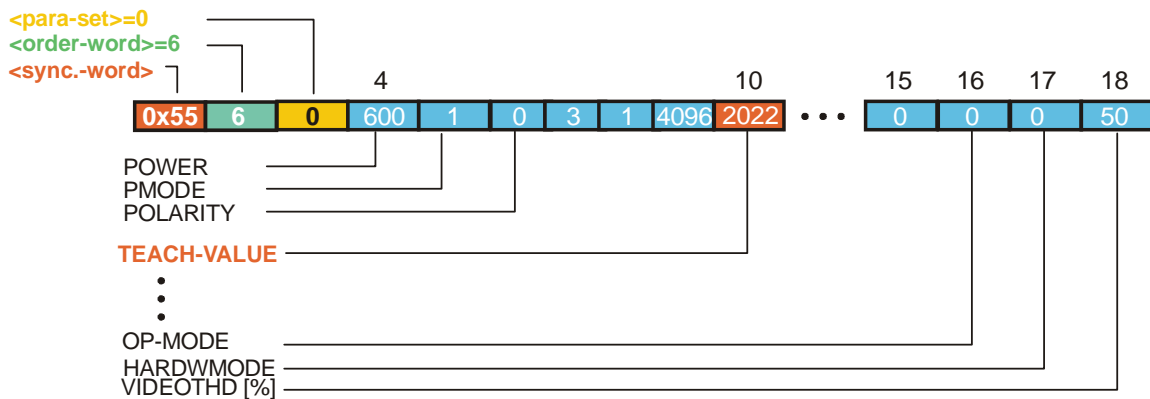
<order-word> = 6    <para-set> = 0

Start the teach function at the L-LAS-LT sensor. The 10th word of the echo contains the new teach value.

**DATA FRAME: PC → SENSOR (18-Words=36Bytes, MSB first)**



**DATA FRAME: SENSOR → PC (18-Words=36Bytes, MSB first)**



**GET measurement values from L-LAS-RAM <order-word> = 8**

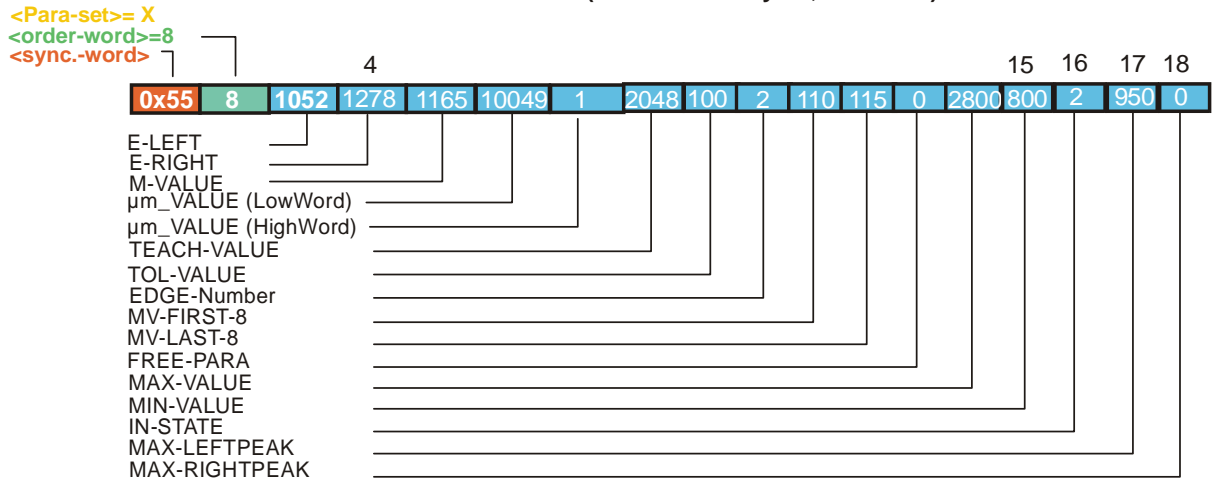
<order-word> = 8    <para-set> = 0

Get the current measurement values from the RAM

**DATA FRAME: PC → SENSOR (18-Words=36Bytes, MSB first)**



**DATA FRAME: SENSOR → PC (18-Words=36Bytes, MSB first)**



Example  $\mu\text{m}$ -Value: 75.584mm = 75584 $\mu\text{m}$  = LowWord (10049) + HighWord (1x65535)

**GET measurement values / recorder values from L-LAS-RAM <order-word> = 18**

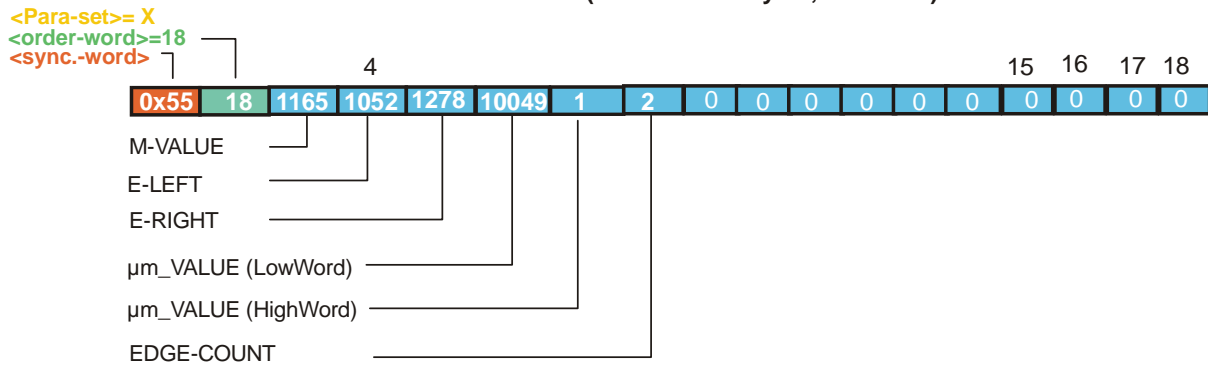
<order-word> = 18    <para-set> = 0

Get the current measurement values from the RAM

**DATA FRAME: PC → SENSOR (18-Words=36Bytes, MSB first)**



**DATA FRAME: SENSOR → PC (18-Words=36Bytes, MSB first)**



Example µm-Value: 75.584mm = 75584µm = LowWord (10049) + HighWord (1x65535)

**Change Baud rate: <order-word> = 190**

<order-word> = 190

Changes the Baud rate at the L-LAS-LT sensor.

The Baud rate is transferred in the 3rd word <para-set>.

9600 Baud = 0, 19200 Baud = 1, 38400Baud = 2, 57600 Baud = 3, 115200 Baud = 4

The transmitted data frame automatically is sent back as an echo by the L-LAS-LT sensor still in the old Baud rate!!

The baud rate only is changed in the RAM program memory (volatile). If the baud rate should be permanently changed, this must be done with parameter RS-232-BAUD in the second parameter set, and by saving in the EEPROM (command 3).

**DATA FRAME: PC → SENSOR (18-Words=36Bytes, MSB first)**



**DATA FRAME: SENSOR → PC (18-Words=36Bytes, MSB first)**



### GET video data from L-LAS-RAM <order-word> = 9

<order-word> = 9    <para-set> = 0,64,128 oder 192  
 Get the current video data from the RAM (only every 8th pixel is read out)

**Step1: DATA FRAME: PC → L-LAS-sensor (18-Words=36Bytes, MSB first)**

<order-word>=9    <block-index> = 0 (first-64-word-block)  
 <sync.-word>

0x55	9	0	0	0	0	0	0	0	0
------	---	---	---	---	---	---	---	---	---

18

**DATA FRAME: L-LAS-sensor → PC (64-Words = 128Byte, MSB first)**

A1	A2	A3	A4	A5	A6	A7	...	A62	A63	A64
----	----	----	----	----	----	----	-----	-----	-----	-----

First block of 64 words are the first 64 pixel of the intensity-profile  
 Attention: Only every 8th pixel is transmitted

**Step2: DATA FRAME: PC → L-LAS-sensor (18-Words=36Bytes, MSB first)**

<block-index> = 64

0x55	9	64	0	0	0	0	0	0	0
------	---	----	---	---	---	---	---	---	---

18

**DATA FRAME: L-LAS-sensor → PC (64-Words = 128Byte, MSB first)**

A65	A66	A67	A68	A69	A70	A71	...	A127	A128
-----	-----	-----	-----	-----	-----	-----	-----	------	------

2nd. block of 64 words: pixel 65 to 128  
 Attention: Only every 8th pixel is transmitted

**Step3: DATA FRAME: PC → L-LAS-sensor (18-Words=36Bytes, MSB first)**

<block-index> = 128

0x55	9	128	0	0	0	0	0	0	0
------	---	-----	---	---	---	---	---	---	---

18

**DATA FRAME: L-LAS-sensor → PC (64-Words = 128Byte, MSB first)**

A129	A130	A131	A132	...	A192	A192
------	------	------	------	-----	------	------

3rd. block of 64 words: pixel 129 to 192  
 Attention: Only every 8th pixel is transmitted

**Step4: DATA FRAME: PC → L-LAS-sensor (18-Words=36Bytes, MSB first)**

<block-index> = 192

0x55	9	192	0	0	0	0	0	0	0
------	---	-----	---	---	---	---	---	---	---

18

**DATA FRAME: L-LAS-sensor → PC (64-Words = 128Byte, MSB first)**

A193	A194	A195	A196	...	A255	A256
------	------	------	------	-----	------	------

3rd. block of 64 words: pixel 193 to 256  
 Attention: Only every 8th pixel is transmitted